User Manual **Version 4.0.1**

V-Link®

Wireless Voltage Node

MicroStrain® Micro Sensors, Big Ideas®

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Welcome

Welcome to MicroStrain! We make tiny sensors that are used in a wide range of applications, including knee implants, civil structures, advanced manufacturing, unmanned military vehicles, and automobile engines. Our sensors have won numerous awards and we pride ourselves on being both innovative and responsive to our customer's unique requirements.

MicroStrain is based in Williston, Vermont and is a privately held corporation. Founded in 1987, our early development focused on producing micro-displacement sensors for strain measurement in biomechanics research applications. Our first sensors were designed for arthroscopic implantation on human knee ligaments; since then, we expanded our product line through continual product improvement.

We introduced a broader line of micro-displacement sensors that could withstand extreme temperatures, hundreds of millions of cycles, and complete submersion in saline. The aerospace and automotive industry found our sensing systems met their requirements and we've worked on many groundbreaking projects.

As our customer base expanded, we continued to innovate by combining multiple sensors along with advanced micro controllers to enhance system performance. We were one of the first sensor companies to add wireless capability so that low power, miniature digital sensors could communicate easily with personal computers and send data to the internet.

Our inclinometer product line was initially developed to measure angles of limbs to help re-animate the limbs of paralyzed individuals. The tiny, lightweight gyro-enhanced orientation modules that resulted from this effort found immediate acceptance for navigation & control of unmanned systems in military and exploratory robotics applications.

Sensors are literally changing our world; we're inspired to work with our customers to introduce advanced sensing technology that will enable the next generation of smarter and safer machines, civil structures, and implanted devices.

Thank you for purchasing a MicroStrain sensor!

Steve Arms
President and CEO, MicroStrain, Inc.

Supported Firmware and Software Versions

Device	Firmware version	Software version
V-Link®	4.99 and higher	Agile-Link™ 1.4.1 and higher
SG-Link®	4.99 and higher	Agile-Link™ 1.4.1 and higher
G-Link®	4.99 and higher	Agile-Link™ 1.4.1 and higher
TC-Link®	4.99 and higher	Agile-Link™ 1.4.1 and higher
USB Base Station	2.0.7 and higher	Agile-Link™ 1.4.1 and higher
Analog Base Station	2.0.7 and higher	Agile-Link™ 1.4.1 and higher
Serial Base Station	2.0.7 and higher	Agile-Link™ 1.4.1 and higher

Table 1

Guide to Relevant Documents

Wireless Node	Document
V-Link®	Agile-Link™ Software Manual
V-Link®	V-Link® Quick Start Guide
V-Link®	V-Link® User Manual
V-Link®	Base Station User Manual
V-Link®	High Speed Streaming Quick Start Guide
SG-Link®	Agile-Link™ Software Manual
SG-Link®	SG-Link® Quick Start Guide
SG-Link®	SG-Link® User Manual
SG-Link®	Base Station User Manual
SG-Link®	High Speed Streaming Quick Start Guide
G-Link®	Agile-Link™ Software Manual
G-Link®	G-Link® Quick Start Guide
G-Link®	G-Link® User Manual
G-Link®	Base Station User Manual
G-Link®	High Speed Streaming Quick Start Guide
TC-Link®	TC-Link® Quick Start Guide (covers Node Monitor)
TC-Link®	TC-Link® User Manual
TC-Link®	Base Station User Manual

Table 2

Overview

The V-Link® is a wireless voltage node and is a specialized member of MicroStrain's Agile-Link™ wireless data acquisition system. The Agile-Link™ system comprises 3 main components: 1) wireless sensor nodes which acquire and transmit strain, voltage, temperature, acceleration and/or other sensor data, 2) base stations which receive and pass the data to a host, and 3) software which operates the system.

The V-Link® provides 7 external measurement channels, being 4 differential input channels (strain channels) primarily designed to support strain gauges of 350 ohm resistance or greater, and 3 single ended input channels (analog channels) designed to support 0-3 volt sensors. The combination of the 7 measurement channels supports a wide range of Wheatstone bridge type and analog sensors including strain gauges, displacement sensors, load cells, torque transducers, pressure sensors, accelerometers, geophones, temperature sensors and inclinometers. The V-Link® also has an on-board temperature sensor.

The V-Link® employs a 12 bit A/D converter to digitize the voltage on the differential input, single ended input and temperature channels. The digital data is passed to the on-board microprocessor, processed with the embedded algorithm, and in turn either passed to its radio for immediate transmission or saved to the 2MB on-board flash memory for later download.

Host computer software displays the data, provides analysis tools, records the data to file and allows the user to configure and actuate the system. The V-Link® may also be used with MicroStrain's Analog base station for stand-alone applications.

The V-Link® may be deployed up to 70 meters (line-of-sight) from its base station, and 100 meters or more with added antenna options.

The V-Link® has a long life internal battery and may be remotely deployed in any number of applications including bridges, machinery, aircraft, production lines and the like.

Multiple V-Link®'s may be deployed around a single base station, each transmitting its data to the base station coincidentally, with the data being passed on to the software for aggregation.

Installation

We suggest these three steps to install your V-Link®:

1) Install the Agile-Link™ software by following the directions given in the *Software Installation* section of this manual.

2) Remove the contents of your V-Link® starter kit.

- Install the antenna on the base station antenna connector. Tighten hand tight; do not over tighten.
- If you have a serial base station (see Figure 1), connect the RS-232 cable to a serial port on your PC and to the serial base station RS-232 connector. Connect the external power supply to the power connector on the serial base station and plug it into a proper power receptacle. Turn the serial base station power switch on and the green LED will illuminate indicating the base station is powered
- If you have a USB base station, plug the USB connector into any USB port on your PC. The blue LED will illuminate indicating the base station is powered.
- If you have an analog base station, connect the USB cable to any USB port on your PC and to the analog base station USB connector on the back panel. Connect the external power supply to the power connector on the back panel of the analog base station and plug it into a proper power receptacle. Depress the red power button on the front panel and the green LED will illuminate indicating the base station is powered.
- Install the antenna on the V-Link® antenna connector. Tighten hand tight; do not over tighten. Insure the V-Link® is turned off (switch down away from cover label).
- Fully charge the V-Link® internal battery following the procedure given in the *Internal Battery* section of this manual.

USB **Serial** **Analog**

Figure 1

3) Follow the step-by-step instructions in the V-Link® *Quick Start Guide* which you will find on the CD or on our web site.

This will get you up and running. From here you will want to use the Agile-Link™ software to familiarize yourself with all the operations of the V-Link®.

Starter Kits, Modules and Options

The V-Link® is available in starter kits, as individual modules and with options.

6312-0000	V-LINK-2400-M	V-LINK-2400-M, V-LINK wireless voltage node. Operates on 2.4 GHz direct sequence spread spectrum, IEEE 802.15.4 radio.
6312-0011	V-LINK-2400-SKA	V-LINK-2400-SKA, V-LINK starter kit includes one V-LINK wireless voltage node, one analog/digital output base station with power supply, charger and Agile-Link software. Operates on 2.4 GHz direct sequence spread spectrum, IEEE 802.15.4 radio.
6312-0041	V-LINK-2400-SK1	V-LINK-2400-SK1, V-LINK starter kit includes one V-LINK wireless voltage node, one USB base station, charger and Agile-Link software. Operates on 2.4 GHz direct sequence spread spectrum, IEEE 802.15.4 radio.
6312-0042	V-LINK-2400-SK2	V-LINK-2400-SK2, V-LINK starter kit includes two V-LINK wireless voltage nodes, one USB base station, charger and Agile-Link software. Operates on 2.4 GHz direct sequence spread spectrum, IEEE 802.15.4 radio.
6313-1000	V-LINK-QBRIDGE	V-LINK-QBRIDGE, quarter bridge customization option for V-Link wireless nodes (customer must specify Bridge Resistance). This will be performed on all Wheatstone Bridge input channels unless otherwise specified.
6313-2000	V-LINK-HBRIDGE	V-LINK-HBRIDGE, half bridge customization option for V-Link wireless nodes (customer must specify Bridge Resistance). This will be performed on all Wheatstone Bridge input channels unless otherwise specified.
6313-3000	V-LINK-IP65-ENCL	V-LINK-IP65-ENCL, IP65/NEMA4 rated high strength fiberglass enclosure, with 9V battery clip. Dimensions: 2.5" x 4.5" x 3".
6313-4000	V-LINK-IP65-XL-ENCL	V-LINK-IP65-XL-ENCL, IP65/NEMA4 rated high strength fiberglass enclosure, with non-rechargeable 3.6V Lithium D cell battery. Dimensions: 2.94" x 2.18" x 6.3".
6313-5000	V-LINK-IP65-XXL-ENCL	V-Link-IP65-XXL-ENCL, IP65/NEMA4 rated high strength fiberglass enclosure, with 3 parallel non-rechargeable 3.6V Lithium D cell batteries. Dimensions: 2.2" x 4.4" x 6.8".

Table 3

6313-7000	V-LINK-IP67-ENCL	V-LINK-IP67-ENCL, IP67 rated enclosure with 3.6V lithium AA battery.
6313-7010	V-LINK-IP67-A	V-LINK-IP67-A, A connector for V-LINK-IP67-ENCL.
6313-7020	V-LINK-IP67-B	V-LINK-IP67-B, B connector for V-LINK-IP67-ENCL.
6313-7030	V-LINK-IP67-TOOL	V-LINK-IP67-TOOL, crimp tool for IP67 enclosure connectors.
6301-0000	AGILE-LINK	AGILE-LINK, AGILE-LINK Software for use with AGILE-LINK family of wireless sensors.
6302-3000	HIGH-G-OPTION	HIGH-G-OPTION, modify wireless nodes to operate in excess of 550 g. Install high g crystals, pot entire assembly and install internal antenna.
6302-4000	IP65-MAG	IP65-MAG, pair of magnetic mounting strips for use with the wireless IP65 enclosures.
6402-0310	ACCEL-TRIAX-3031-50	ACCEL-TRIAX-3031-50, Triaxial Accelerometer, +/-50g full scale range, 0.75"x0.75"x1.0".
6402-0110	ACCEL-TRIAX-3031-100	ACCEL-TRIAX-3031-100, Triaxial Accelerometer, +/-100g full scale range, 0.75"x0.75"x1.0".
6402-0210	ACCEL-TRIAX-3031-200	ACCEL-TRIAX-3031-200, Triaxial Accelerometer, +/-200g full scale range, 0.75"x0.75"x1.0".
6402-0410	ACCEL-TRIAX-3031-500	ACCEL-TRIAX-3031-500, Triaxial Accelerometer, +/-500g full scale range, 0.75"x0.75"x1.0".
6313-6010	CHARGER-A-INT	CHARGER-A-INT, V-Link, wall mount charging unit. 100-240 VAC at 50-60 Hz input with 9VDC at 560mA output.

Table 3 con't

Common Terms

These terms are in common use throughout the manual:

- **Address:** Each node has a unique address from 1 to 65534 which identifies the node to the base station and software.
- **Base Station:** The transceiver base station attaches to your host computer and provides communication between the software and the node(s).
- **Bits:** The digital equivalent of voltage on the node. The node excites all sensor circuits with +3 Volts. The return from the sensor is 0 to 4096 bits representing 0 to 3 volts.
- **Broadcast:** Any of a number of commands (trigger, sleep, erase, etc.) transmitted at the same instant to multiple nodes.
- **Browse Triggers:** The software action whereby one can display and analyze the datalogging sessions in CSV format.
- **Channel Actions:** Coefficients contained on-board the node to instruct the host software to scale engineering units.
- **Configuration:** A general term applied to the node indicating the streaming or datalogging environment. The number of active channels, sampling rate, offset, hardware gain, etc. are all components of a node's configuration.
- **Continuous:** A term used to describe a sampling session (datalogging, streaming, LDC, HSS) where the time length of the session is undefined.
- **Cycle Power:** A command transmitted to the node to re-boot the node.
- **Datalogging:** Datalogging is a node action whereby all active channels (and the sensors attached to them) are sampled and the data acquired is written to non-volatile memory on-board the node. The data is not transmitted to the base station and software during datalogging. Datalogging can either be finite (have a user defined start and end time) or continuous (continue until all datalogging memory is consumed).
- **Download:** Download is the node action whereby the node transmits all of its datalogging data to the base station and software for file saving.
- **Erase:** A command transmitted to the node to erase all datalogging sessions.
- **Finite:** A term used to describe a sampling session (datalogging, streaming, LDC, HSS) where the time length of the session is defined.
- **High Speed Streaming: High Speed Streaming** (HSS) is a node action whereby all active channels (and the sensors attached to them) are sampled and the data acquired is transmitted to the base station and software. The data is not written to non-volatile memory during HSS. HSS can either be finite (have a user defined start and end time) or continuous (continue until the power is cycled on the node). It differs from Streaming in that it offers faster data rates.
- **Low Duty Cycle:** Low Duty Cycle (LDC) is a node action whereby all active channels (and the sensors attached to them) are sampled and the data acquired is "blipped" to the base station and software. The data is not written to non-volatile memory during LDC. LDC can either be finite (have a user defined start and end time) or continuous (continue until the power is cycled on the node).

- **Node:** The node is the wireless transceiver that carries the sensors and provides communication with the base station. The G-Link®, V-Link®, SG-Link® and TC-Link® are all nodes.
- **Ping:** A byte is transmitted by the base station to a particular node and the node responds by echoing the byte indicating communication exists between the base station and the node.
- **Plugins:** Software 'wizards' which aid in the configuration of the node's sensors.
- **Range Test:** A continuous string of pings used to validate communication between the base station and the node over distance and obstruction.
- **Read/write EEPROM:** Commands transmitted to the node to read or write parameters stored in the node's operating system.
- **SEDT:** Sensor Event Driven Trigger is a method whereby a ceiling or floor output threshold can be set in the node to automatically trigger datalogging.
- **Sleep:** A command transmitted to the node to set a node into sleep configuration.
- **Streaming:** Streaming is a node action whereby all active channels (and the sensors attached to them) are sampled and the data acquired is transmitted to the base station and software. The data is not written to non-volatile memory during streaming. Streaming can either be finite (have a user defined start and end time) or continuous (continue until the power is cycled on the node).
- **Sweep Rate:** A node setting which determines the number of times all active channels are sampled during a finite sampling session.
- **Trigger:** A command transmitted to the node to begin a datalogging session.
- **Wake:** A command transmitted to the node to recover a node in sleep configuration.

Operation

Let's discuss the operation of the V-Link® and base station in conjunction with the Agile-Link™ host software.

The V-Link® has four differential input channels (strain channels), three single ended input channels (analog channels) and an on-board temperature sensor channel. The V-Link® samples these eight channels using four different selectable methods. The data is either stored temporarily on-board the V-Link® or immediately transmitted to a base station, depending on the sampling method. The base station is read by the host software as data is received, and the host software displays and/or saves the data to file.

The four differential inputs are assigned to channels 1, 2, 3 and 4; the three single ended inputs are assigned to channels 5, 6 and 7; and the on-board temperature sensor is assigned to channel 8. The differential channels with their connected sensors are excited with 3 volts and the resultant is first passed through a 2-stage amplification (being a fixed instrumentation amplifier and a user programmable gain amplifier with programmable offset, on through an anti-aliasing filter (3dB down @ 500 Hz; low pass filters with cutoff @ 500 Hz), and into the 12 bit A-to-D converter. The three single ended inputs with their connected sensors and the temperature sensor are excited with 3 volts and feed directly into the 12 bit A-to-D converter. The 12 bit A-to-D converter sends the eight channels to the microprocessor. The firmware in the microprocessor processes the digital sampling into raw data and, depending on the sampling method selected, either writes the data as it is captured to the flash memory or sends the data through the serial communication interface to the radio transceiver. The transceiver in turn transmits the data to any listening base station.

Please refer to the *Electrical Block Diagram* section of this manual for a visual representation of the V-Link®, base station and host software operation. Please refer to the *Differential Input Channels* and *Single Ended Input Channels* sections of this manual for an in-depth discussion of their use and operation.

In the **DATALOGGING** sampling method, the V-Link® may be configured to sample data as fast as 2048 samples per channel per second to as slow as 32 samples per channel per second. Datalogging can be finite or continuous. In finite datalogging, a sampling duration is set and the datalogging session will last the duration once initiated. The data will be written to the memory on-board the V-Link® during the session. In continuous datalogging, the one session will last until the memory is full. Multiple finite datalogging sessions may be conducted with the V-Link® before its memory is full. No data is transmitted over the air to the base station during datalogging. When datalogging is completed (one or more sessions), the software provides for the data to be downloaded from the V-Link® through the base station. The software parses the data into CSV formatted files for further analysis.

In the **STREAMING** sampling method, the V-Link® sampling rate is directly dependent on the number of sensor channels which are active. With 1 channel active, the channel

will be sampled at a rate of 736 samples per second; with 4 channels active, each channel will be sampled at a rate of 565 samples per second; with 8 channels active, each channel will be sampled at a rate of 424 samples per second. Streaming duration can be finite or continuous. In finite streaming, a sampling duration is set and the streaming session will last the duration once initiated. In continuous streaming, the streaming session will last until the host software stops the session or the power is cycled on the V-Link®. The data is transmitted over the air to the base station during streaming; no data is written to the on-board memory during the session. During streaming, the software receives the data from the base station, parses, caches and displays the data and provides for the data to be saved into CSV formatted files for further analysis. Please note that the Analog base station will support streaming through its analog backplane; see the *Base Station* manual for details.

In the **LOW DATA DUTY** sampling method, the V-Link® may be configured to sample data as fast as 500 samples per channel per second to as slow as 1 sample per channel per hour. Low Duty Cycle can be finite or continuous. In finite low duty cycle, a sampling duration is set and the low duty cycle session will last the duration once initiated. In continuous low duty cycle, the low duty cycle session will last until the host software stops the session or the power is cycled on the V-Link®. The data is transmitted over the air to the base station during low duty cycle; no data is written to the on-board memory during the session. During low duty cycle, the software receives the data from the base station, parses, caches and displays the data and provides for the data to be saved into CSV formatted files for further analysis. Please note that the Analog base station will support streaming through its analog backplane; see the *Base Station* manual for details.

In the **HIGH SPEED STREAMING** sampling method, the V-Link® sampling rate is directly dependent on the number of sensor channels which are active. With 1 channel active, the channel will be sampled at the rate of 4000 samples per second; with 4 channels active, each channel will be sampled at the rate of 1000 samples per second; with 8 channels active, each channel will be sampled at the rate of 500 samples per second. High Speed Streaming can be finite or continuous. In finite high speed streaming, a sampling duration is set and the high speed streaming session will last the duration once initiated. In continuous high speed streaming, the high speed streaming session will last until the host software stops the session or the power is cycled on the V-Link®. The data is transmitted over the air to the base station during high speed streaming; no data is written to the on-board memory during the session. During high speed streaming, the software receives the data from the base station, parses, caches and displays the data and provides for the data to be saved into CSV formatted files for further analysis.

Please review the *Sampling Rates* section of this manual for datalogging, streaming, low duty cycle and high speed streaming sampling rate details.

Multiple V-Link®'s (nodes) and/or base stations may be operated at the same time depending on the sampling method in use.

In the **Datalogging** sampling method, you may trigger a datalogging session on any number of V-Link®s at the same instant by broadcasting a datalogging command from one base station to all the nodes. In this case, all nodes and the base station operate on the same frequency. All nodes would receive the command and independently perform their datalogging session. Each node would be downloaded separately.

In the **Streaming** sampling method, you may trigger a streaming session on up to 16 V-Link®s at the same instant by broadcasting a streaming command from multiple base stations to each base station's corresponding node. In this case, a base station would be deployed for each node and each pair would be set to a separate frequency so as not to conflict with other pairs. All nodes would receive the command and independently stream their data to the paired base station. Agile-Link™ software is capable of handling up to 4 node/base station pairs; application developers would be able to operate up to 16 pairs in this fashion. This limit of 16 results from the number of available frequencies within the band spectrum of the V-Link® radio.

In the **Low Duty Cycle** sampling method, multiple V-Link®s can share the same frequency since each node is not transmitting continuously. You may start a low duty cycle session on any number of V-Link®s at the same instant by broadcasting a low duty cycle command from one base station to all the nodes. All nodes receive the command and independently begin transmitting their low duty cycle data. The base station receives the data from all the nodes and passes it on to the host software.

It should be noted here that when using multiple nodes with one base station in low duty cycle mode, the total number of nodes that can be simultaneously sampled is dependent on the number of active channels and the sampling rate. As the number of active channels increases and/or sampling rates increase, the total number of nodes that can be sampled falls. Likewise, as the number of active channels decreases and/or sampling rates decrease, the total number of nodes that can be sampled increases.

In the **High Speed Streaming** sampling method, you may trigger a high speed streaming session on up to 16 V-Link®s at the same instant by broadcasting a high speed streaming command from multiple base stations to each base station's corresponding node. In this case, a base station would be deployed for each node and each pair would be set to a separate frequency so as not to conflict with other pairs. All nodes would receive the command and independently stream their data to the paired base station. MicroStrain's High Speed Streaming software is capable of handling only 1 node/base station pair; application developers would be able to operate up to 16 pairs in this fashion. This limit of 16 results from the number of available frequencies within the band frequency of the V-Link® radio.

The analog base station has an additional feature relating to sampling methods. It normally is configured to support up to 8 channels of data from a single node. However, it may be configured to support up to 8 nodes, that is to say, it may be configured to handle one channel of data from up to 8 individual V-Link®s. Please refer to the Agile-

Link™ Base Station manual which is contained on the Agile-Link™ CD and on our web site for detailed instructions on its use with V-Link®.

The V-Link® has an additional datalogging feature which we describe as **Sensor Event Driven Trigger (SEDT)**. In SEDT, the V-Link® may be configured to commence datalogging automatically each time a "ceiling" or "floor" sensor output is met. For example, you may set the V-Link® so that a datalogging session is triggered whenever channel 1 (a differential input channel) exceeds (goes through the ceiling of) 40 microstrain. The session will begin automatically, run its finite duration and stop. With the next 40 microstrain ceiling event, the V-Link® would again run a datalogging session automatically without manual intervention.

When the V-Link® is not sampling, it can be in one of two states: Sleep or idle. In Sleep mode, the V-Link®, on a settable interval (by default 5 seconds), momentarily awakens and listens for any commands. If a command is heard, it wakes and responds to the command; if no command is heard, it goes back to sleep. This sleep function is used to conserve battery power. In idle mode, the V-Link® is awake and listening for commands from a base station.

Several configuration/operational/test functions exist for the V-Link®; some of the more often used functions are listed below.

- A **Verify** will test whether the base station and software are communicating successfully.
- A **Ping** will test whether a single byte transmission from the base station to the node is successful.
- A **Range Test** will test whether communication is being maintained over a period of time between the base station and the node.
- A **Cycle Power** will have the effect of manually cycling the power on the node.
- **Node Discovery** allows the base station to detect any node on any frequency as it is powered on.
- **Load Node Information** reads and displays the model, serial number, firmware version and other statistics of the node.
- **Frequency** allows reading and setting of the channel on which the node is operating.
- **Read/Write EEPROM** allows direct reading and setting of parameters maintained in EEPROM.

Please see the Agile-Link™ software manual for more information on software accessible features of the V-Link®.

Base Stations

The V-Link® is designed to operate with any of the Agile-Link™ wireless family base stations. These base stations include the USB base station, the Analog base station and the Serial base station. Please refer to the Agile-Link™ Base Station manual which is contained on the Agile-Link™ CD and on our web site for detailed instructions on their use with V-Link®.

USB Base Station

The MicroStrain USB base station is a transceiver which provides a communication link between a host computer and the Agile-Link™ family of wireless nodes including V-Link®, SG-Link®, G-Link® and TC-Link®. The USB base station employs a 2.4 GHz radio with 16 selectable channels to communicate with the remote nodes. The USB base station is connected to a host computer via a USB connection and is operated with MicroStrain's Agile-Link™ software. The USB base station, under instruction from the software, wirelessly communicates with the Agile-Link™ nodes, alternately sending commands and configurations, and receiving responses and data. The USB base station sends all of the commands available to the nodes including ping, datalog, stream data, erase, read and write EEPROM, etc. The USB base station in turn receives acknowledging responses from the nodes and passes datalogging downloads, streaming data, high speed streaming data and low duty cycle data to the host computer. The USB base station is capable of maintaining communications with multiple nodes. Its broadcast mode allows the simultaneous issuance of several commands to multiple nodes.

Analog Base Station

The MicroStrain Analog base station is a transceiver which provides a communication link between a host computer and the Agile-Link™ family of wireless nodes including V-Link®, SG-Link®, G-Link® and TC-Link®. The Analog base station employs a 2.4 GHz radio with 16 selectable channels to communicate with the remote nodes. The Analog base station is connected to a host computer via a USB or an RS-232 connection and is operated with MicroStrain's Agile-Link™ software. The Analog base station, under instruction from the software, wirelessly communicates with the Agile-Link™ nodes, alternately sending commands and configurations, and receiving responses and data. The Analog base station sends all of the commands available to the nodes including ping, datalog, stream data, erase, read and write EEPROM, etc. The

Analog base station in turn receives acknowledging responses from the nodes and passes datalogging downloads, streaming data, high speed streaming data and low duty cycle data to the host computer. The Analog base station is capable of maintaining communications with multiple nodes. Its broadcast mode allows the simultaneous issuance of several commands to multiple nodes. The Analog base station also features direct analog output of wireless node data on its back panel and is deployable in a stand-alone condition without need of host computer.

Serial Base Station

The MicroStrain Serial base station is a transceiver which provides a communication link between a host computer and the Agile-Link™ family of wireless nodes including V-Link®, SG-Link®, G-Link® and TC-Link®. The Serial base station employs a 2.4 GHz radio with 16 selectable channels to communicate with the remote nodes. The Serial base station is connected to a host computer via an RS-232 connection and is operated with MicroStrain's Agile-Link™ software. The Serial base station, under instruction from the software, wirelessly communicates with the Agile-Link™ nodes, alternately sending commands and configurations, and receiving responses and data. The Serial base station sends all of the commands available to the nodes including ping, datalog, stream data, erase, read and write EEPROM, etc. The Serial base station in turn receives acknowledging responses from the nodes and passes datalogging downloads, streaming data, high speed streaming data and low duty cycle data to the host computer. The Serial base station is capable of maintaining communications with multiple nodes. Its broadcast mode allows the simultaneous issuance of several commands to multiple nodes.

Differential Input Channels

The V-Link® has four differential input channels. These channels are designed to accommodate strain gauges with 350 ohm resistance or greater. The V-Link® by default is configured to support a full Wheatstone bridge installation. The V-Link® can also be ordered from the factory configured to support half and quarter bridge installations. It is important to know how your V-Link® has been configured before proceeding with use. You may wish to check your invoice or you may inspect the circuit board assembly for factory-applied completion resistors. The location of these completion resistors are described in Appendix 6 of this manual.

The V-Link® powers the differential input channel with +3 volts DC at up to 50 mA for bridge excitation. A special feature of the excitation is that it will revert to a 'pulsed' mode when sampling rates are below 100 Hz in order to conserve power. Programmable gain is user-adjustable and allows the bridge circuit to be amplified to suit the characteristics of the particular strain gauges in use; this gain can be set from 210 to 4844. Programmable offset is also user-adjustable and allows for the 'zeroing' of strain gauge output. Strain gauge bridges can have significant offset due to a number of factors including initial ohmic error in the gauge itself, installation of the gauge on a non-flat surface, initial offset error in the electronics, and small errors in the bridge completion resistors. Details of programmable gain and offset use may be found in the Agile-Link™ software manual. Further conditioning (noise reduction) is provided by an anti-aliasing filter (- 3dB down @ 500 Hz; low pass filters with cutoff @ 500 Hz).

The V-Link® differential input channels additionally contain a precision 499 Kohm (499000 ohm) resistor shunt resistor. This resistor is employed by Agile-Link™ software to perform a precise shunt calibration of the V-Link® and the Wheatstone bridge installation. Alternatively, users may either use Agile-Link™ software to perform a shunt calibration using an external precision resistor, or perform a shunt calibration using a method of their own design.

The 3 volt signal is digitized by the V-Link®'s 12-bit A/D converter, creating a 0 to 4096 'bit' digital range. As explained elsewhere, the Agile-Link™ system operates digitally by resolving all sensor voltages to 'bits', transmitting the bits by radio to the base station, carrying the bits into host software, and finally returning these bits to volts at the software level. Agile-Link™ software further provides an on-board function (Strain Wizard) which allows engineering units (microstrain) to be output and displayed directly from the software. Please refer to the Strain Wizard Help in the Agile-Link™ software for detailed use.

In the pages following you will find wiring diagrams which detail the specifics for installing quarter, half and full bridges. Please also refer to the *Terminal Block Connectors* section for other important details and practice.

A word of caution: Strain gauges with resistance below 350 ohm, in particular 120 ohm gauges, may be used with V-Link®, although they are not recommended. The nature of 120 ohm gauges is such that temperature is a critical factor in their performance and the user should be aware of the effects of temperature on the measurements derived.

Finally, the science and use of strain gauges is a large subject. MicroStrain sales and support are always available to discuss your particular requirements.

Connecting a quarter bridge strain gauge

This example assumes the V-Link® is configured with the optional internal **quarter** bridge completion resistors. If not, the completion of the bridge (shown as internal circuitry) must be completed externally. The three wire arrangement is recommended in order to cancel thermal effects of the lead wire resistance (RL). It is strongly recommended that shielded wiring be used, as this can significantly reduce system noise. Please note that the shield of each cable must be grounded at one location only, to prevent the occurrence of ground loops. Shielded wiring can be purchased from Alphawire (part number 1122, www.alphawire.com); a sample is included with each starter kit.

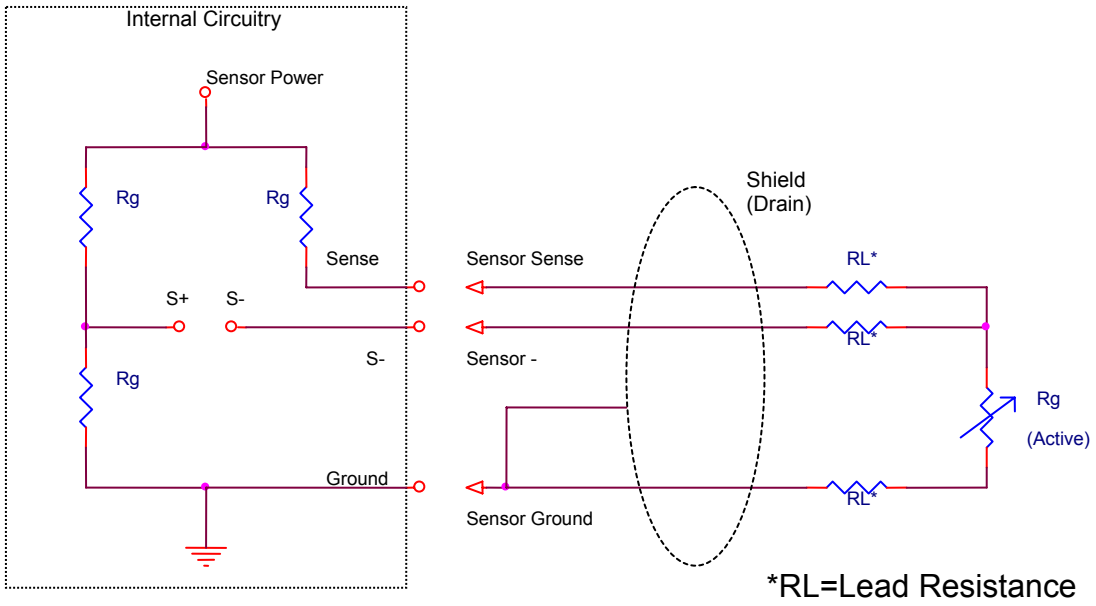


Figure 2

Sensor Channel#	Sense Pin# (Signal)	S- Pin# (Signal)	Ground Pin#
1	14	15	17
2	19	18	17
3	11	10	8
4	6	7	8

Table 4

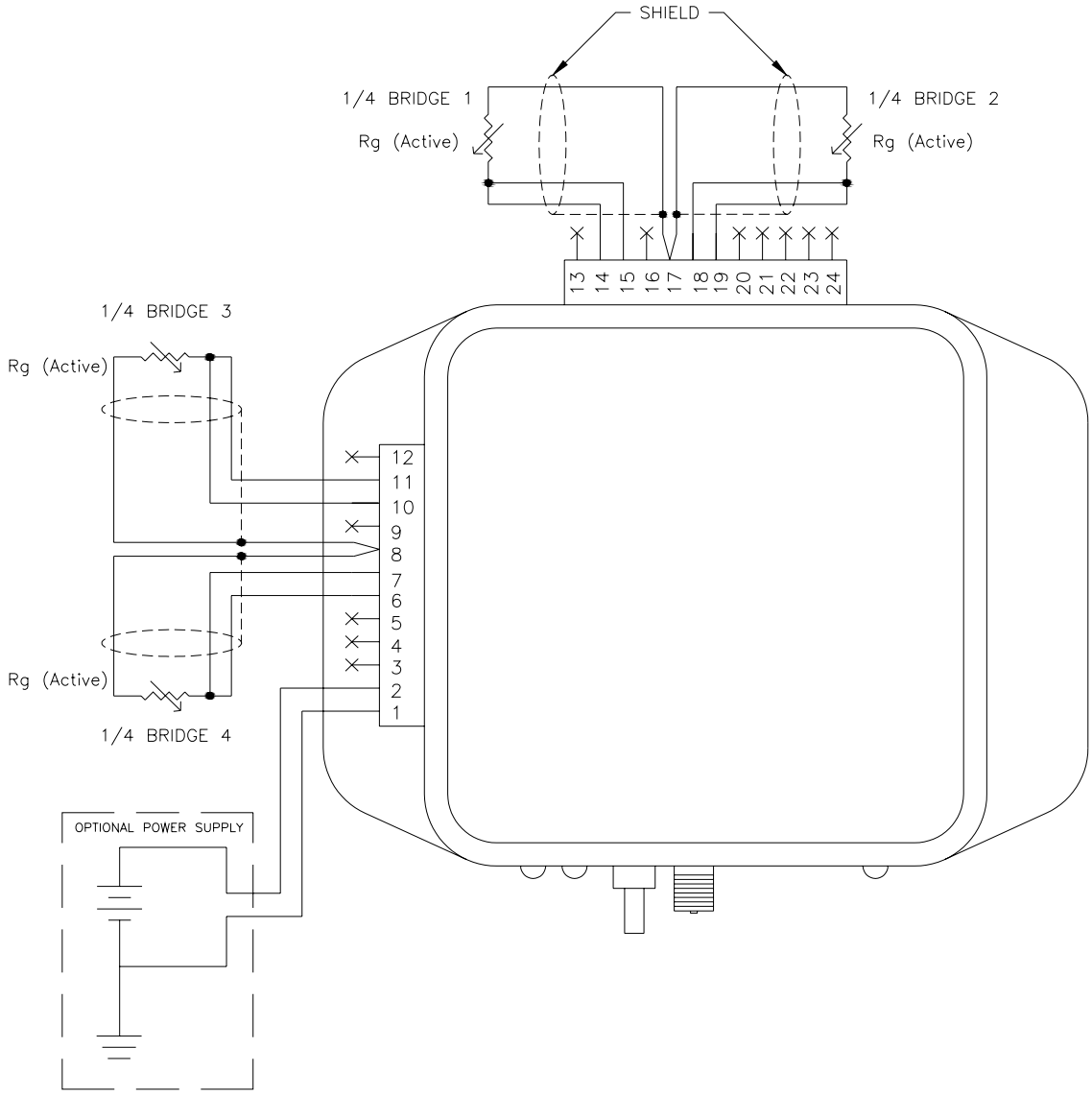

SHIELD
1/4 BRIDGE 1
Rg (Active)
1/4 BRIDGE 2
Rg (Active)
13 14 15 16 17 18 19 20 21 22 23 24
1/4 BRIDGE 3
Rg (Active)
12
11
10
9
8
7
6
5
4
3
2
1
Rg (Active)
1/4 BRIDGE 4
OPTIONAL POWER SUPPLY

Figure 3

Connecting a half bridge strain gauge

This example assumes the V-Link® is configured with the optional internal **half** bridge completion resistors. If not, the completion of the bridge (shown as internal circuitry) must be completed externally. It is strongly recommended that shielded wiring be used, as this can significantly reduce system noise. Please note that the shield of each cable must be grounded at one location only, to prevent the occurrence of ground loops. Shielded wiring can be purchased from Alphawire (part number 1122, www.alphawire.com); a sample is included with each starter kit.

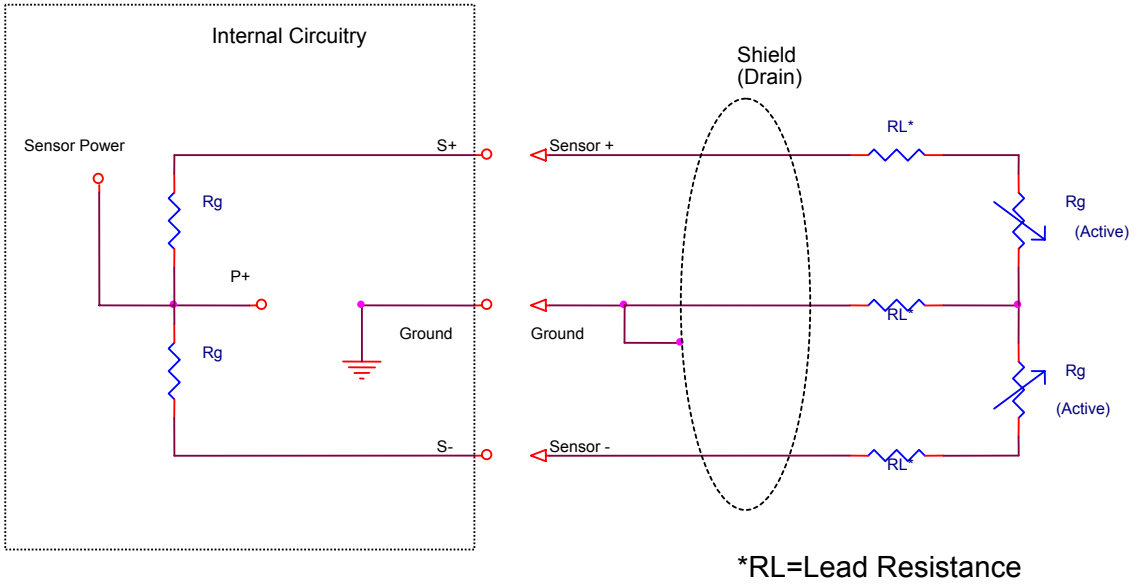


Figure 4

Sensor Channel#	S+ Pin# (Signal+)	S- Pin# (Signal-)	Ground Pin#
1	13	15	17
2	20	18	17
3	12	10	8
4	5	7	8

Table 5

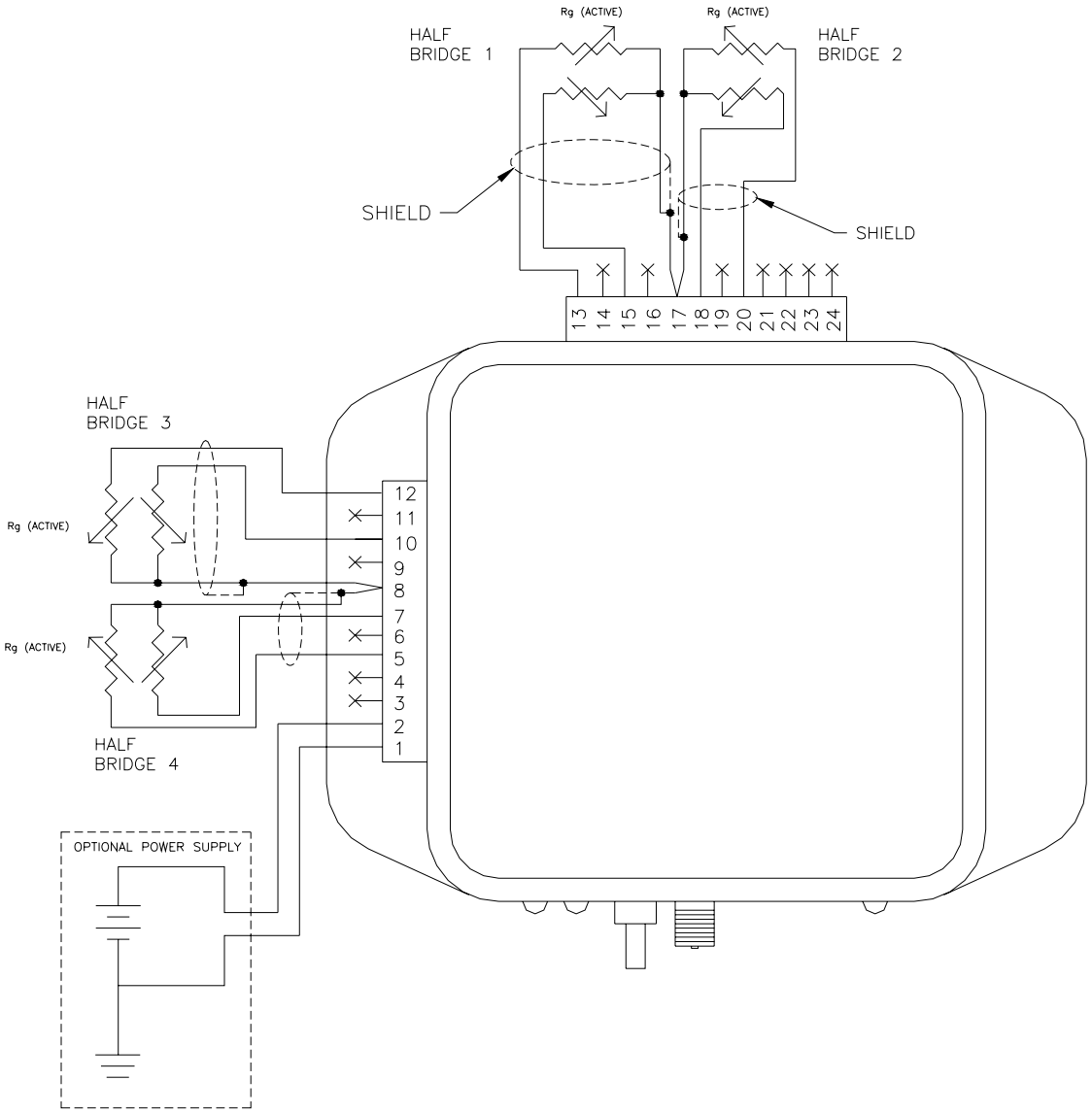
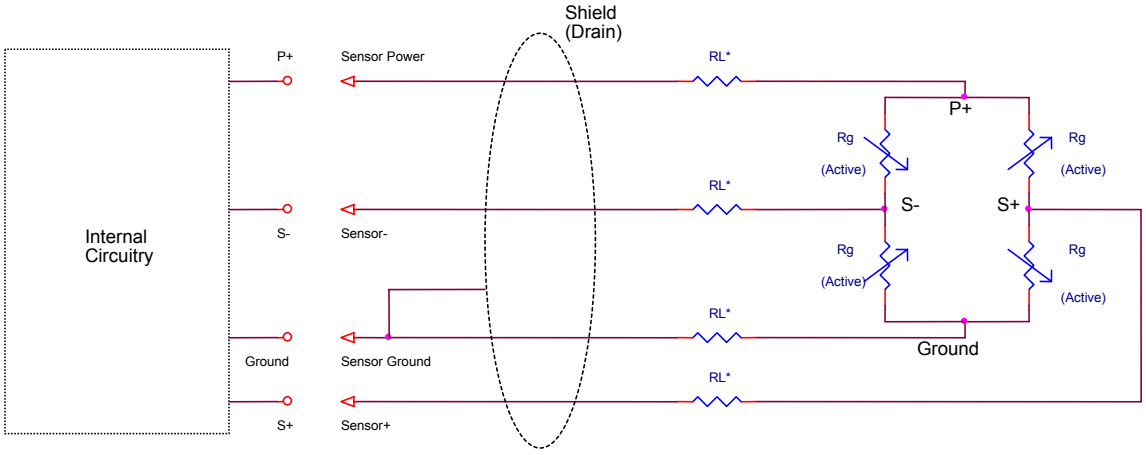

Rg (ACTIVE)
Rg (ACTIVE)
HALF
BRIDGE 1
HALF
BRIDGE 2
SHIELD
SHIELD
13
14
15
16
17
18
19
20
21
22
23
24
HALF
BRIDGE 3
Rg (ACTIVE)
Rg (ACTIVE)
12
11
10
9
8
7
6
5
4
3
2
1
HALF
BRIDGE 4
OPTIONAL POWER SUPPLY

Figure 5

Connecting a full bridge strain gauge

This example assumes the V-Link® is configured with the optional internal **full** bridge completion. In this arrangement, the user is responsible for all bridge completion. It is strongly recommended that shielded wiring be used, as this can significantly reduce system noise. Please note that the shield of each cable must be grounded at one location only, to prevent the occurrence of ground loops. Shielded wiring can be purchased from Alphawire (part number 1122, www.alphawire.com); a sample is included with each starter kit.



*RL=Lead Resistance

Figure 6

Sensor Channel#	P+ Pin# (Signal Power)	S+ Pin# (Signal+)	S- Pin# (Signal-)	Ground Pin#
1	16	13	15	17
2	16	20	18	17
3	9	12	10	8
4	9	5	7	8

Table 6

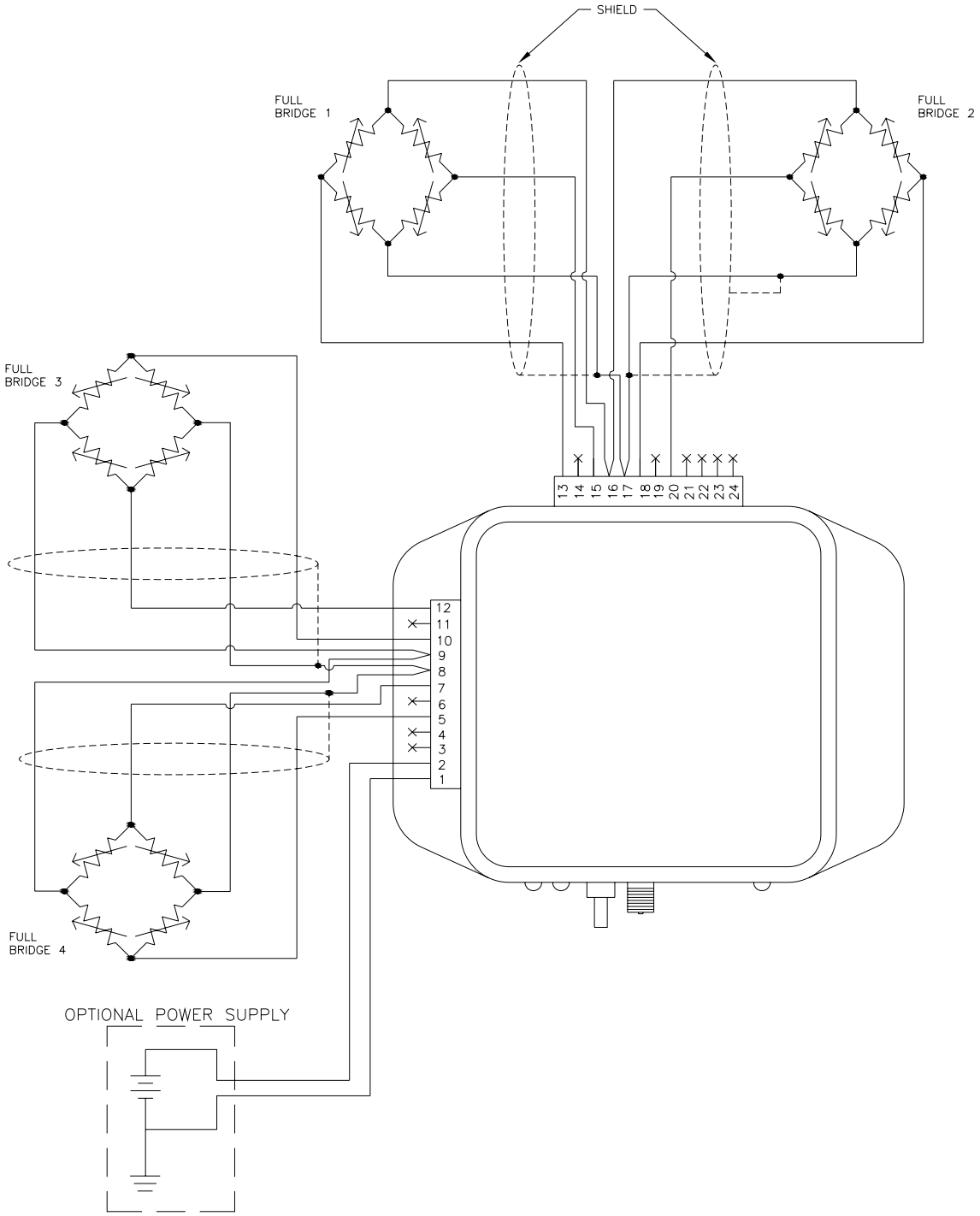

SHIELD
FULL BRIDGE 1
FULL BRIDGE 2
FULL BRIDGE 3
FULL BRIDGE 4
13 14 15 16 17 18 19 20 21 22 23 24
12 11 10 9 8 7 6 5 4 3 2 1
OPTIONAL POWER SUPPLY

Figure 7

Single Ended Input Channels

The V-Link® has three single ended input channels. These channels will accommodate most 0-3 volt DC analog output sensors including accelerometers, pressure sensors, geophones, temperature sensors, inclinometers and the like.

The V-Link® can provide +3 volts DC up to 50 mA to the sensor. Alternatively, the sensor can be powered with +3 volts by any external constant source. In this case, the current draw of the sensor will not compromise the V-Link®, i.e., it may exceed 50 mA.

Typical wiring to the V-Link® would follow the patterns exampled below. Please refer to the *Terminal Block Connectors* section for more details.

In our first example, let's use a photocell that requires power from the V-Link®. The photocell presents 3 leads; lead 1 is the power lead, lead 2 is the ground lead and lead 3 is the signal lead. In this case, connect lead 1 to pin 9 (P+), connect lead 2 to pin 1 (GND), and connect lead 3 to pin 4 (Ain5).

In our second example, let's use a photocell that is being powered externally. The photocell presents 2 leads; lead 1 is the ground lead and lead 2 is the signal lead. In this case, connect lead 1 to pin 1 (GND), and connect lead 2 to pin 4 (Ain5).

The 3 volt signal is digitized by the V-Link®'s 12-bit A/D converter, creating a 0 to 4096 'bit' digital range. As explained elsewhere, the Agile-Link™ system operates digitally by resolving all sensor voltages to 'bits', transmitting the bits by radio to the base station, carrying the bits into host software, and finally returning these bits to volts at the software level. 0 volts = 0 bits, 2048 bits = 1.5 volts, 4096 bits = 3 volts, and so forth. To state it as a formula: 3 Volts / 4096 bits = 0.000732 bits per volt. The volts recreated on the host side can be further processed into engineering units by using the scaling provided by the sensor manufacturer. Agile-Link™ software provides an on-board function (Custom Formula) which allows for engineering units to be output and displayed directly from the software if the manufacturer's scaling formula is linear. Polynomial scaling, non-linear scaling, and so forth will have to be dealt with on a post-processing basis by the user.

In some case, users may want to use sensors which require 5 volt (or more) excitation. A voltage divider can be employed between the sensor and the V-Link® terminal block connector to facilitate a 3 volt input. Caution should be exercised in such cases, as any inherent signal noise will be amplified.

The V-Link® can not be used to measure sensors which output negative voltage. The V-Link® should not be used with sensors with an impedance of greater than 5000 ohms.

Users are always welcome to contact MicroStrain sales or support to discuss specific sensor applications in more detail.

Temperature Sensor

General Information

- The V-Link® has an on-board, solid state temperature sensor mounted on the surface of the circuit board.
- Specifications for this National Semiconductor Model LM60 sensor may be found at: http://www.national.com/mpf/LM/LM60.html
- The temperature sensor output is presented on channel 8 of the V-Link®.
- The temperature sensor has a measurement range of -25˚C to +70˚C range, accuracy ± 0.5˚C (@25˚).

In use with Agile-Link™ software

The V-Link® temperature sensor outputs 6.25 mV/°C. The Agile-Link™ software uses and any other application should use this formula to calculate temperature:

$$Temp\left[°C\right] = \frac{\left\{BitsOut \times \left(\frac{3000\left[mV\right]}{4096\left[Bits\right]}\right)\right\} - 424\left[mV\right]}{6.25\left[\frac{mV}{°C}\right]}$$

Terminal Block Connectors

The V-Link® has two 12-pin terminal blocks mounted on the sidewall of the enclosure. These terminal blocks accommodate the 4 differential input channel sensor connections, the 3 single ended channel sensor connections, and an external power connection. The two female connectors made into the sidewall of the enclosure are Phoenix Contact Model 1881545. The two removable male connectors are Phoenix Contact Model 1881422. Specific details on these connectors may be found at: http://www.phoenixcon.com/.

Tip: Strain gauge leads may be beefed up by tinning and/or adding stiff wire to the end of the lead so that the leads are held firmly in the terminal block connector. Loose connections will cause erroneous readings.

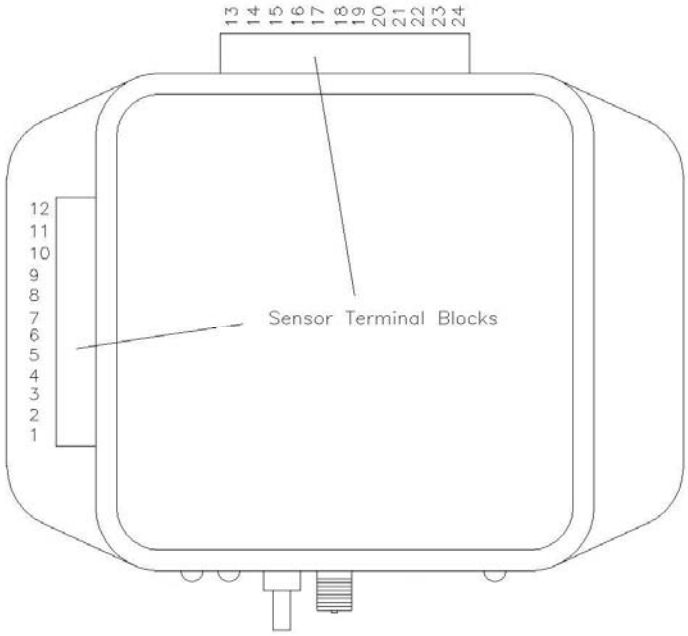


Figure 8

V–Link Pin Assignments

1. GROUND	13. SENSOR 1+
2. Vin (OPTIONAL)	14. SENSOR 1 SENS
3. Ain6	15. SENSOR 1–
4. Ain5	16. SENSOR POWER OUT
5. SENSOR 4+	17. GROUND
6. SENSOR 4 SENS	18. SENSOR 2–
7. SENSOR 4–	19. SENSOR 2 SENS
8. GROUND	20. SENSOR 2+
9. SENSOR POWER OUT	21. Vout1
10. SENSOR 3 –	22. Vout2
11. SENSOR 3 SENS	23. Vout3
12. SENSOR 3 +	24. Ain7

Figure 8A

V-Link® Pin Assignments

Signal Name	Reference	Direction	Description
Pin 1: Ground	Ground	N/A	This is the system ground. This provides the reference to which signal inputs are measured, and provides a return for power supply.
Pin 2: Power Supply	Vin	Input	Optional power supply, an internal Li-Ion rechargeable battery is built in; however, an external DC power supply can be provided at this pin to replace use of internal battery. The DC supply should be 3.6V to 9V, and capable of supplying sufficient *maximum* current for the application (usually 20-50 mA, depending on external sensors and node configuration). Note: When using this pin, the internal power switch must be switched.
Pin 3: Analog Single Ended Input 6	Ain6	Input	This input is a single ended 0-3 volt input for transducers and/or signal conditioners that provide a high level voltage output. This signal connection is routed directly to channel 6 on the A/D converter. Note: The source impedance should be less than 5K ohms
Pin 4: Analog Single Ended Input 5	Ain5	Input	This input is a single ended 0-3 volt input for transducers and/or signal conditioners that provide a high level voltage output. This signal connection is routed directly to channel 5 on the A/D converter. Note: The source impedance should be less than 5K ohms
Pin 5: Channel 4 Sensor Differential Amplifier Input +	Sensor4+	Input	This is the positive input to the channel 4 programmable gain amplifier (PGA)
Pin 6: Channel 4 Three Wire Input	Sensor4Sens	Input	This is the input for three wire mode on quarter bridge strain gauge bridges. Leave unconnected for non quarter strain gauge bridge applications.
Pin 7: Channel 4 Sensor Differential Amplifier Input -	Sensor4-	Input	This is the negative input to the channel 4 PGA
Pin 8: Ground	Ground	N/A	This is the system ground. This provides the reference to which signal inputs are measured, and provides a return for power supply.
Pin 9: Sensor Power	Sensor Power Out	Output	This signal provides output power to external sensors. This output is only active (“on”) when the unit is sampling the sensors. Maximum combined load on this pin and pin 16 is 50 mA.
Pin 10: Channel 3 Sensor Differential Amplifier Input -	Sensor3-	Input	This is the negative input to the channel 3 PGA

Table 7

Pin 11: Channel 3 Three Wire Input	Sensor3Sens	Input	This is the input for three wire mode on quarter bridge strain gauge bridges. Leave unconnected for non quarter strain gauge bridge applications.
Pin 12: Channel 3 Sensor Differential Amplifier Input +	Sensor3+	Input	This is the positive input to the channel 3 PGA
Pin 13: Channel 1 Sensor Differential Amplifier Input +	Sensor1+	Input	This is the positive input to the channel 1 PGA
Pin 14: Channel 1 Three Wire Input	Sensor1Sens	Input	This is the input for three wire mode on quarter bridge strain gauge bridges. Leave unconnected for non quarter strain gauge bridge applications.
Pin 15: Channel 1 Sensor Differential Amplifier Input -	Sensor1-	Input	This is the negative input to the channel 1 PGA
Pin 16: Sensor Power	Sensor Power Out	Output	This signal provides output power to external sensors. This output is only active (“on”) when the unit is sampling the sensors. Maximum combined load on this pin and pin 9 is 50 mA.
Pin 17: Ground	Ground	N/A	This is the system ground. This provides the reference to which signal inputs are measured, and provides a return for power supply.
Pin 18: Channel 2 Sensor Differential Amplifier Input -	Sensor2-	Input	This is the negative input to the channel 2 PGA
Pin 19: Channel 2 Three Wire Input	Sensor2Sens	Input	This is the input for three wire mode on quarter bridge strain gauge bridges. Leave unconnected for non quarter strain gauge bridge applications.
Pin 20: Channel 2 Sensor Differential Amplifier Input +	Sensor2+	Input	This is the positive input to the channel 2 PGA
Pin 21: AnalogOutput1	Vout1	Output	Not in use.
Pin 22: AnalogOutput2	Vout2	Output	Not in use.
Pin 23: AnalogOutput3	Vout3	Output	Not in use.
Pin 24: Analog Single Ended Input 7	Ain7	Input	This input is a single ended 0-3 volt input for transducers and/or signal conditioners that provide a high level voltage output. This signal connection is routed directly to channel 7 on the A/D converter. Note: The source impedance should be less than 5K ohms

Table 7 con’t

LEDs

The V-Link® has three LED indicators on its sidewall. The LEDs signal the various operating states of the V-Link® to the user.

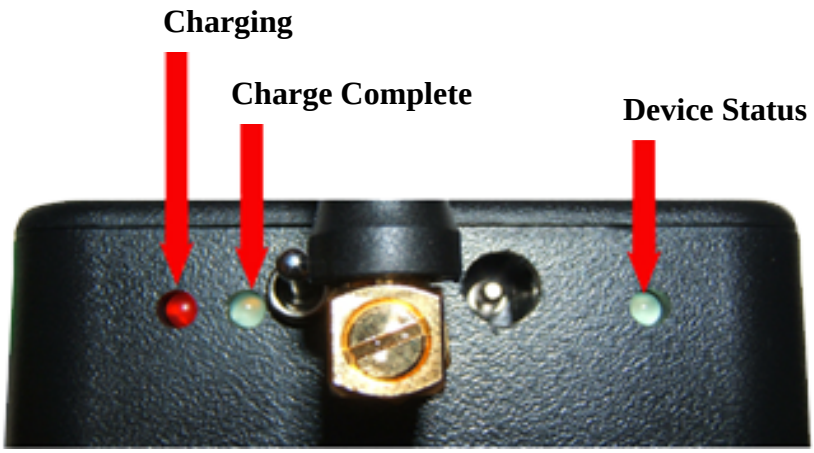


Figure 9

Charging LED

The red Charging LED illuminates when the external power supply is connected and continues to illuminate while the internal battery charging circuit is active. When the internal battery is fully charged, the LED turns off in favor of the green Charge Complete LED. The red Charging LED will also turn off if the external power supply is removed prior to full charge.

Charge Complete LED

The green Charge Complete LED will illuminate only during a charging session and only when the battery is fully charged. The green Charge Complete LED will turn off if the external power supply is removed.

Device Status LED

The green Device Status LED indicates the current state of the V-Link®. When the V-Link® is switched on, the green Device Status LED will rapidly flash several times and in a moment, begin 'throbbing' on and off every 1 second. The rapid flashes indicate a successful boot-up. The 'throbbing' indicates that the V-Link® is active and in an idle state.

The Device Status LED has several states during **normal** operation:

State	**LED appearance**
Booting up	Rapidly flashes 10 times when power is applied/recycled
Active and idle	'Throbbing' on and off every 1 second
Datalogging	Illuminates continuously
Streaming	Illuminates continuously
High Speed Streaming	Illuminates continuously
Low Duty Cycle	Blips on/off based on sampling rate
Ping	Blips on/off once for each ping
Range Test	Blips on/off at high rate giving appearance of continuous illumination
Read/Write EEPROM	Rapidly flashes several times
Sleep	Faint blip on/off based on Check Radio Interval

Table 8

The Device Status LED has several states during **error** operation:

State	**LED appearance**
Radio error	Blinks slowly 4 times on boot-up
On-board 2MB flash memory error	Blinks slowly 5 times on boot-up

Table 8A

Radio and Antenna

The V-Link® and its base station employ a 2.4 GHz IEEE 802.15.4 compliant radio transceiver for wireless communication. The radio complies with ETSI EN 300 328, EN 300 440 class 2, FCC CFR-47 part 15 and ARIB STD-T66. The radio is license free worldwide.

The radio is a direct-sequence spread spectrum radio and can be configured to operate on any of 16 separate frequencies ranging from 2.405 GHz to 2.480 GHz. Following the 802.15.4 standard, the Agile-Link™ family aliases these frequencies as channel 11 through channel 26 and the V-Link® default setting is equivalent to 2.475 GHz (channel 25) .

The V-Link® has a 2.4 GHz omni-directional, right-angle, ¼ wave antenna extending from the faceplate of the V-Link®. The antenna is mounted to a male reverse polarity SMA connector (RP-SMA) extending through the enclosure from the circuit board assembly. Antenna specifications may be found at:
http://www.antennafactor.com/documents/ANT-2.4-CW-RCS_Data_Sheet.pdf

The stated range for the V-Link® is up to 70 meters line-of-sight from its base station. An optional high gain antenna may be added to the base station and/or node to increase the range up to 280 meters line-of-sight.

Please review our technical note *Maximizing Wireless Communication Range* at:
http://www.microstrain.com/pdf/TechNote_2400_RangeExtendingAntennae.pdf

The V-Link® may experience radio performance problems on the 2.4 GHz band as a result of the many other devices that share this license free zone. If you suspect that other devices in the immediate area might be interfering with the V-Link®'s transmissions, simply select a different channel. As we said earlier, the V-Link® can be set to operate on any of 16 different frequencies within the band.

The V-Link® can also be provided with an optional internal wire lead type antenna (so that there is no antenna mast extending from the enclosure). Please contact your MicroStrain Sales representative for more information.

Node Addressing

Each node has a unique address from 1 to 65534 which identifies the node to the base station and software. Typically, the factory assigns the last 4 digits of the node's serial number as the address, and changes to this address are not recommended except under special circumstances.

Address 65535 is a specialized broadcast node address. For example, if several nodes hear a command for node 65535 to start datalogging, they will all initiate datalogging simultaneously. It is extremely important that no particular node be assigned the 65535 broadcast address.

Note: The Streaming and High Speed Streaming commands in Agile-Link™ software can not use the broadcast 65535 address.

Sample Duration Calculations

Datalogging, streaming, low duty cycle and high speed streaming sampling sessions can all be set to last a finite duration, a finite amount of time. Finite sample duration is a value ranging from 100 to 65500, in increments of 100.

A datalogging example: We set the number of active channels to 3. We set the sample rate to 32. We set the sampling duration to 1000. We trigger the session. We download the session. We find that we have 1000 rows of data, with each row containing 3 channels of sensor data. We see that the session lasted ~31.25 seconds.

Another datalogging example: We set the number of active channels to 1. We set the sample rate to 1024. We set the sampling duration to 10000. We trigger the session. We download the session. We find that we have 10000 rows of data, with each row containing 1 channel of sensor data. We see that the session lasted ~9.77 seconds.

From this is becomes clear how the sampling duration can be thought of as a time setting:

- In our first example, we can divide a sampling duration of 1000 by a sample rate of 32 to equal ~31.25 seconds.
- In our second example, we can divide a sampling duration of 10000 by a sample rate of 1024 to equal ~9.77 seconds.

A streaming example: We set the number of active channels to 3. We can't set the sample rate because that is fixed in hardware and we know it will be 617. We set the sampling duration to 10000. We start the session. We save the session. We find that we have 10000 rows of data, with each row containing 3 channels of sensor data. We see that the session lasted ~16.21 seconds. As before, 10000 sampling duration divided by 617 sample rate = ~16.21 seconds.

A low duty cycle example: We set the number of active channels to 3. We set the sample rate to 1. We set the sampling duration to 100 (100 is the minimum setting in Agile-Link™ software). We start the session. We save the session. We find that we have 100 rows of data, with each row containing 3 channels of sensor data. We see that the session lasted ~100 seconds. As before, 100 sampling duration divided by 1 sample rate = ~100 seconds.

A high speed streaming example: We set the number of active channels to 4. We can't set the sample rate because that is fixed in hardware and we know it will be 1000. We set the sampling duration to 10000. We start the session. We save the session. We find that we have 10000 rows of data, with each row containing 4 channels of sensor data. We see that the session lasted ~10 seconds. As before, 10000 sampling duration divided by 1000 sample rate = ~10 seconds.

Time Stamping

The V-Link® node and Agile-Link™ software handle time stamping of datalogging, streaming, low duty cycle and high speed streaming data in different ways. The table below describes the various methods:

Sampling Method	Time Stamp	Source	Clock Type	Stability
Datalogging	Omitted to maximize data rate	Node	Crystal	+/-25ppm
Streaming	Omitted to maximize data rate	Node	Crystal	+/-25ppm
LDC ≤ 1 Hz(1)	16-bit counter	Node	RC	+/-10%
	Absolute time stamp	PC	Windows OS	---
LDC > 1 Hz	16-bit counter	Node	Crystal	+/-25ppm
High Speed Streaming	16-bit counter	Node	Crystal	+/-25ppm

Table 9

Notes:

(1) 16-bit counter and absolute time stamp are both applied.

Power

The V-Link® is normally powered by its internal rechargeable Lithium Ion battery and may also be powered by an external source.

On/Off Switch

The V-Link® has a 2 position on-and-off toggle switch on its sidewall next to the antenna post. With the V-Link® placed flat with the label up, **OFF** is down and **ON** is up.

Internal Battery

The V-Link® contains an internal rechargeable Ultralife® brand 3.7 volt Lithium Ion battery UBPC003 http://www.ultralifebatteries.com/datasheet.php?ID=UBP003.

The V-Link® internal battery has a manufacturer stated nominal capacity of 600 mAh @ C/5 Rate @ 23° C.

The V-Link® internal battery has a manufacturer stated recharge cycle life of >500 cycles @ C/5 to 80% of initial capacity. A rule-of-thumb would be to expect at least 500 recharges (from fully depleted to full charge) before discharge capacity begins to drop.

The internal battery should only be charged with the Phihong brand external power supply Model PSA05R-090 http://www.phihong.com/assets/pdf/PSA05R.pdf provided in the V-Link® starter kit. The power supply is a 'switching' supply and may receive an input from 100 to 240 Volts AC. It outputs +9 Volts DC. A set of 4 plug adapters are provided to accommodate most countries' electrical services.

The V-Link® should be fully charged before each use. Charging may take up to several hours depending on battery depletion.

Charging procedure:

- Turn off the V-Link® On/Off Switch.
- Insert external power supply male connector into the V-Link® barrel connector.
- Insert power supply into wall or other electrical service.
- Observe that the red Charging LED illuminates. If it does not, remove the external power supply male connector and re-insert it into the V-Link® barrel connector until the red Charging LED illuminates. Please see the *LEDs* section of this manual for more details.
- Charging has completed when you observe that the red Charging LED turns off and the green Charge Complete LED illuminates.
- Remove external power supply male connector.
- Turn on the V-Link® On/Off Switch.
- **Note:** The V-Link® should normally be operated with the external power supply disconnected and therefore not charging the battery.

Here are some example battery life calculations:

- Streaming with one 350 ohm strain gauge consumes ~33 mA. If the V-Link® battery capacity is 600 mAh, the device will stream for ~18 hours before re-charging is required.
- Datalogging with one 350 ohm strain gauge consumes ~33 mA. If the V-Link® battery capacity is 600 mAh, the device will datalog for ~18 hours before re-charging is required.
- Sleep mode consumes ~0.5 mA. If the V-Link® battery capacity is 600 mAh, the device will sleep for ~1200 hours before re-charging is required.

Bypassing the Internal Battery

The V-Link® may be directly powered by external batteries, external regulated power supply or other external source. The source should deliver stable voltage, must range between 3.2 to 9.0 volts DC, and must be capable of sourcing at least 50 mA. The power may be applied through the external power supply barrel connector on the side wall of the V-Link®. Polarity must be observed: the center post is + (positive) and the outside barrel is ground. Alternatively, external power may be applied through pin 1 (GND) and pin 2 (Vin) on the terminal block connectors. Please see the *V-Link® Pin Assignments* section of this manual for more details.

IMPORTANT: There is an internal 2-position switch on the top of the V-Link® circuit board assembly that must be switched to the battery bypass position. It is accessed by removing the 4 cover screws and the cover of the enclosure. The figure below shows the Default position for internal battery and the Bypass position for external power source.

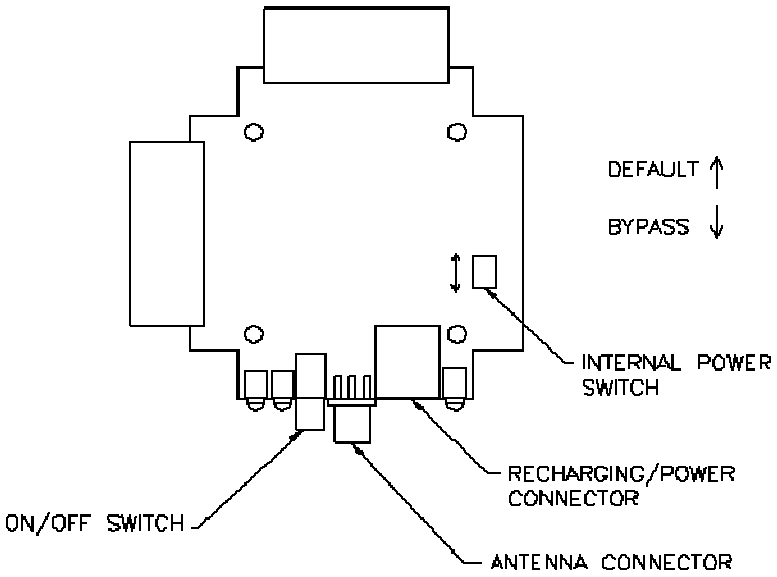


Figure 10
(V-Link® Rev F forward)

Power Profile

Power consumption on the V-Link® is influenced by a wide range of variables including operating mode, sampling rate and number of active channels. A current power profile which outlines power consumption for the matrix of operating states is available at:

http://www.microstrain.com/pdf/V-Link_PowerProfile_node_FW_4_98.pdf

Standard Enclosure

The V-Link® standard enclosure is flame rating UL 94-5VA ABS plastic. It is a 2 part assembly with base and removable cover. It is custom manufactured for MicroStrain. Please see the *Mechanical Drawings* section of this manual for dimensions.

Figure 11

Optional Enclosures

The V-Link® is optionally available installed within IP65/NEMA 4 enclosures which provide environmental protection and/or larger battery capacity.

IP65 standard: Provides for 1) protection against a wire touching dangerous parts and, 2) sealed against dust.

NEMA 4 standard: Computer enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, windblown dust, splashing water, and hose-directed water; and that will be undamaged by the external formation of ice on the enclosure.

V-LINK-IP65-ENCL

Description: IP65/NEMA4 rated high strength fiberglass enclosure, with 9V battery clip.

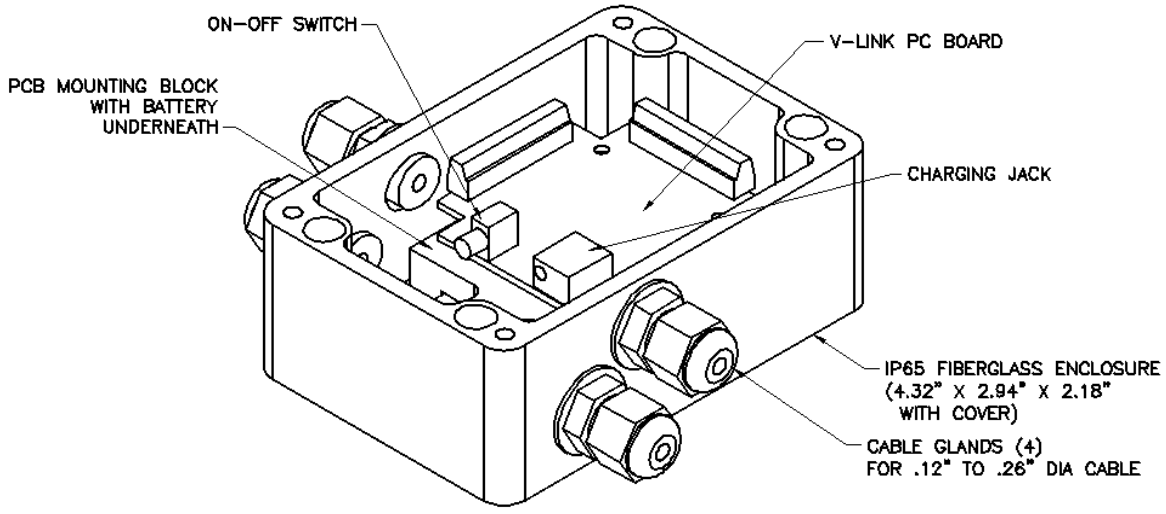

ON–OFF SWITCH
V–LINK PC BOARD
PCB MOUNTING BLOCK WITH BATTERY UNDERNEATH
CHARGING JACK
IP65 FIBERGLASS ENCLOSURE (4.32" X 2.94" X 2.18" WITH COVER)
CABLE GLANDS (4) FOR .12" TO .26" DIA CABLE

Figure 12

V-LINK-IP65-XL-ENCL

Description: IP65/NEMA4 rated high strength fiberglass enclosure, with non-rechargeable 3.6V Lithium D cell battery.

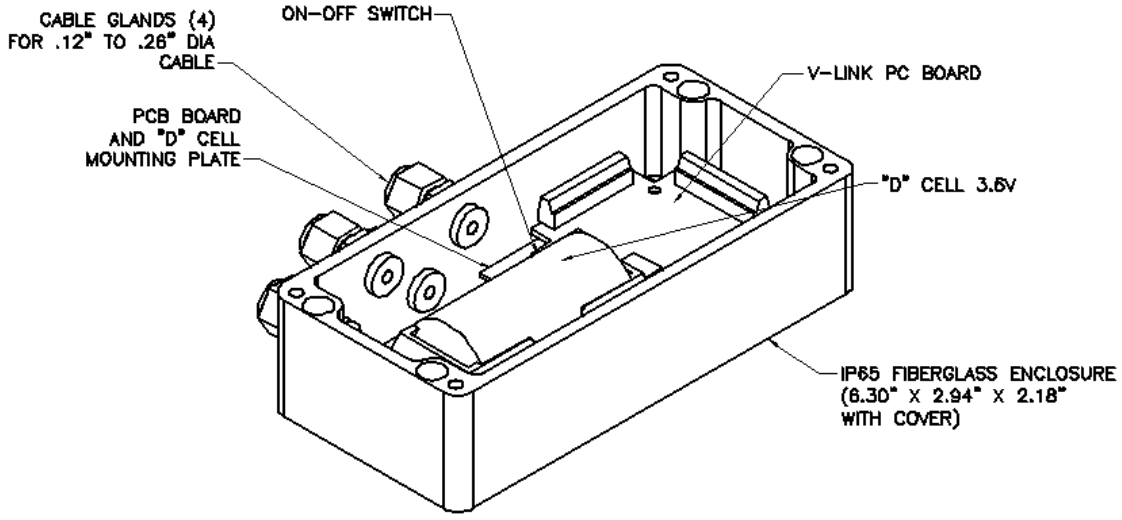


Figure 13

V-LINK-IP65-XXL-ENCL

Description: IP65/NEMA4 rated high strength fiberglass enclosure, with 3 parallel non-rechargeable 3.6V Lithium D cell batteries.

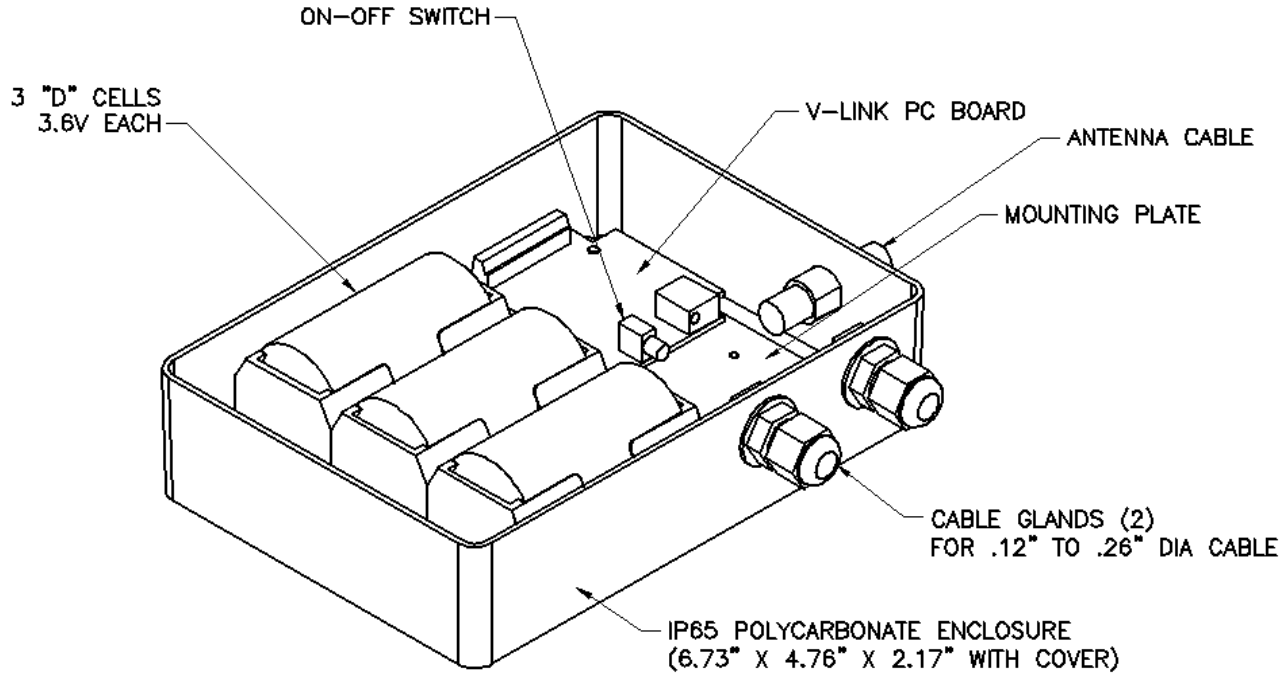


Figure 14

High G Option

The V-Link® may be optionally purchased with provisions made to withstand higher G forces. These provisions will allow the V-Link® to operate in excess of 550 g.

These provisions can include any or all of the following:

- The cavity of the standard enclosure is filled with an epoxy adhesive. The epoxy fills all voids between the enclosure and the circuit board assembly. The epoxy provides outstanding thermal shock, impact and vibration resistance.
- The radio and microprocessor crystals are replaced with higher rated crystals.
- The external mast antenna and its mount are replaced with a short insulated wire lead. The lead extends from the enclosure and is pliable.

Operating Temperature

The V-Link® with its standard internal battery and standard enclosure will operate between -20° C and +60° C. The battery and enclosure limit this range.

The V-Link® electronics alone will operate between -40° C and +85° C.

Extended temperature ranges can be achieved with custom batteries and enclosures. Please contact a MicroStrain Sales Engineer with your requirements.

Sampling Rates

As described in more detail elsewhere in this manual, the V-Link® has four sampling modes, being 1) Datalogging, 2) Streaming, 3) Low Duty Cycle and 4) High Speed Streaming. Each of these modes supports a unique set of sampling rates. In Datalogging and Low Duty Cycle modes, you may choose the sampling rate for the session. In Streaming and High Speed Streaming, the sampling rate is a function of the number of active channels being sampled and may not be set by the user.

Datalogging

The sampling rate may be set to any of the following rates:

- 32 samples per active channel per second
- 64 samples per active channel per second
- 128 samples per active channel per second
- 256 samples per active channel per second
- 512 samples per active channel per second
- 1024 samples per active channel per second
- 2048 samples per active channel per second

Streaming

The sampling rate is a function of the number of active channels:

- If 1 channel is active, the sampling rate will be 736 samples per second for the channel.
- If 2 channels are active, the sampling rate will be 679 samples per active channel per second.
- If 3 channels are active, the sampling rate will be 617 samples per active channel per second.
- If 4 channels are active, the sampling rate will be 565 samples per active channel per second.
- If 5 channels are active, the sampling rate will be 520 samples per active channel per second.
- If 6 channels are active, the sampling rate will be 485 samples per active channel per second.
- If 7 channels are active, the sampling rate will be 452 samples per active channel per second.
- If 8 channels are active, the sampling rate will be 424 samples per active channel per second.

Low Duty Cycle

The sampling rate may be set to any of the following rates:

- 500 samples per second for each active channel
- 250 samples per second for each active channel
- 100 samples per second for each active channel
- 50 samples per second for each active channel

- 25 samples per second for each active channel
- 10 samples per second for each active channel
- 5 samples per second for each active channel
- 2 samples per second for each active channel
- 1 sample per second for each active channel
- 1 sample every 2 seconds for each active channel
- 1 sample every 5 seconds for each active channel
- 1 sample every 10 seconds for each active channel
- 1 sample every 30 seconds for each active channel
- 1 sample every 60 seconds for each active channel
- 1 sample every 2 minutes for each active channel
- 1 sample every 5 minutes for each active channel
- 1 sample every 10 minutes for each active channel
- 1 sample every 30 minutes for each active channel
- 1 sample every 60 minutes for each active channel

High Speed Streaming

The sampling rate is a function of the number of active channels:

- If 1 channel is active, the sampling rate will be 4,000 samples per second for the channel.
- If 2 channels are active, the sampling rate will be 2,000 samples per active channel per second.
- If 3 channels are active, the sampling rate will be 1,333 samples per active channel per second.
- If 4 channels are active, the sampling rate will be 1,000 samples per active channel per second.
- If 5 channels are active, the sampling rate will be 800 samples per active channel per second.
- If 6 channels are active, the sampling rate will be 666 samples per active channel per second.
- If 7 channels are active, the sampling rate will be 570 samples per active channel per second.
- If 8 channels are active, the sampling rate will be 500 samples per active channel per second.

Datalogging Memory

- The V-Link® contains 2 megabytes of memory reserved for storage of datalogging.
- As a bit of background, the memory is actually organized into 8,191 ‘pages’ with each page able to hold 132 data points or a total of 8,191 pages x 132 data points = ~1,081,212 data points.
- Let’s look at some sample datalogging sessions and see how they consume memory.

Example 1

- We set the V-Link® with channels 1, 2 and 3 active, with a sampling rate of 2,048 samples per channel per second and a sweep rate of 20,000 (9.77 seconds).
- This session will produce 20,000 sweeps x 3 channels = 60,000 data points.
- This session will consume 60,000 data points / 1,081,212 data points = ~5% of the datalogging memory.
- Therefore we could run 100% / 5% = ~20 consecutive finite datalogging sessions before we would have to download the data.

Example 2

- We set the V-Link® with channel 3 active, with a sampling rate of 512 samples per channel per second and a sweep rate of 10,000 (19.53 seconds).
- This session will produce 10,000 sweeps x 1 channels = 10,000 data points.
- This session will consume 10,000 data points / 1,081,212 data points = ~1% of the datalogging memory.
- Therefore we could run 100% / 1% = ~100 consecutive finite datalogging sessions before we would have to download the data.

Example 3

- We set the V-Link® with channels 1, 2 and 3 active, with a sampling rate of 1,024 samples per channel per second, with continuous datalogging enabled and memory fully erased.
- This session will produce 1,024 samples per second x 3 channels = 3,072 data points per second.
- This session will last 1,081,212 data points / 3,072 data points per second = ~352 seconds until the datalogging memory is full and the datalogging is automatically ended.

Factory Calibration and Testing

Calibration

The V-Link® has no particular components which require factory calibration and certification.

Testing

The V-Link® receives final precision testing prior to being shipped. Tests are conducted on the four differential input channels (strain channels), the three single ended input channels (analog channels), the internal temperature sensor channel, the internal battery and other components. The original Functional Test Checklist is included with each V-Link®. This document details test results as well as radio channel setting, bridge completion, and on-board shunt resistor value. This document should be safeguarded for future use.

General Specifications

Input Channels	Up to 8 input channels: 4 full differential, 350 Ω resistance or higher (with optional bridge completion), 3 single ended inputs (0-3 volts maximum), and internal temperature sensor
Temperature Sensor (channel 8)	-25˚C to +70˚C range, typical accuracy ± 0.5˚C (at 25˚C)
Measurement Accuracy	± 0.1% typical
Resolution	± 1 bit (0.024%)
DC Bridge Excitation	+3 volts DC at 50 mA maximum (pulsed to sensors for sample rates of 100 Hz and below to conserve power)
Programmable Gain	Software programmable for differential input channels from 210 to 4844 (can be reduced with hardware resistor change)
Programmable Offset	Software programmable, maximum allowable input offset is ± 1.5 volts
Analog to Digital (A/D) Converter	Successive approximation type, 12 bit resolution
Data Storage Capacity	2 megabytes (approximately 1,000,000 data points)
Data Logging Mode	Log up to 1,000,000 data points (from 100 to 65,500 samples or continuous) at 32 Hz to 2048 Hz
Sensor event driven trigger	Commence datalogging when threshold exceeded
Real-time streaming mode	Transmit real time data from node to PC - rate depends on number of active channels: 1 channel - 4 KHz, 2 channels - 2 KHz, 3 channels - 1.33 KHz, 4 channels - 1 KHz, 5 channels - 800 Hz, 6 channels - 666 Hz, 7 channels - 570 Hz, 8 channels - 500 Hz
Low duty-cycle mode	Supports multiple nodes on single RF channel, total update bandwidth of 500 Hz divided by number of nodes
Synchronization between nodes	Datalogging 100 µsec ± 50 ppm, LDC mode time stamped at PC
Sample rate stability	Datalogging and LDC mode (2Hz to 500 Hz) ± 25 ppm (90 msec/hour) LDC mode (1 Hz to 2 samples /hour) ± 10%
Wireless Shunt Calibration	Channels 1 to 4. Internal shunt calibration resistor 499 KΩ
Radio Frequency (RF) Transceiver Carrier	2.4 GHz, direct sequence spread spectrum, license free worldwide (2.405 to 2.480 GHz) - 16 channels. Radiated power 0 dBm (1mW)
RF Data Packet Standard	IEEE 802.15.4, open communication architecture

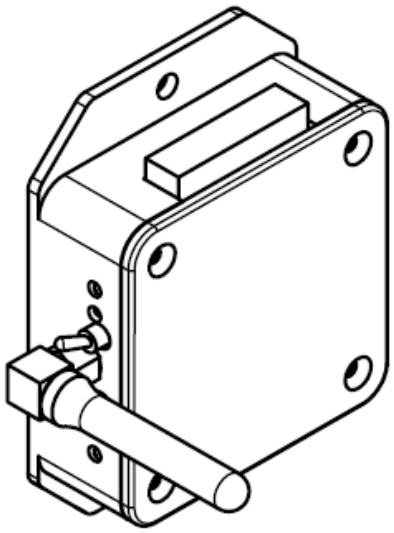
Table 10

RF Programming & Downloading	8 minutes to download full memory
Range for Bi-directional RF Link	70 m line-of-sight, up to 300 m with optional high gain antenna
Internal Li-Ion Battery	3.7 volt lithium ion rechargeable battery, 600 mAh capacity. Customer may supply external power from 3.2 to 9 volts
Power Consumption	V-Link node only: real-time streaming - 25 mA, datalogging - 25 mA, sleeping - 0.5 mA External sensors: 350 Ω strain gauge - 8 mA, 1000 Ω strain gauge - 3 mA (add sensor consumption to above to calculate total power consumption)
Operating Temperature	-20 to +60°C with standard internal battery and enclosure, extended temperature range optional with custom battery and enclosure. -40 to +85°C for electronics only
Dimensions	88 mm x 72 mm x 26 mm including mounting tabs and screw terminal block input connector (board only 72 mm x 65 mm x 24 mm). For dimensioned print go to www.microstrain.com
Weight	97 grams
Case	ABS plastic
Software	Agile-Link™ Windows XP compatible
PC Comm	Serial port, 115.2 kBaud

Table 10 con't

Mechanical Drawings

Enclosure Dimensions



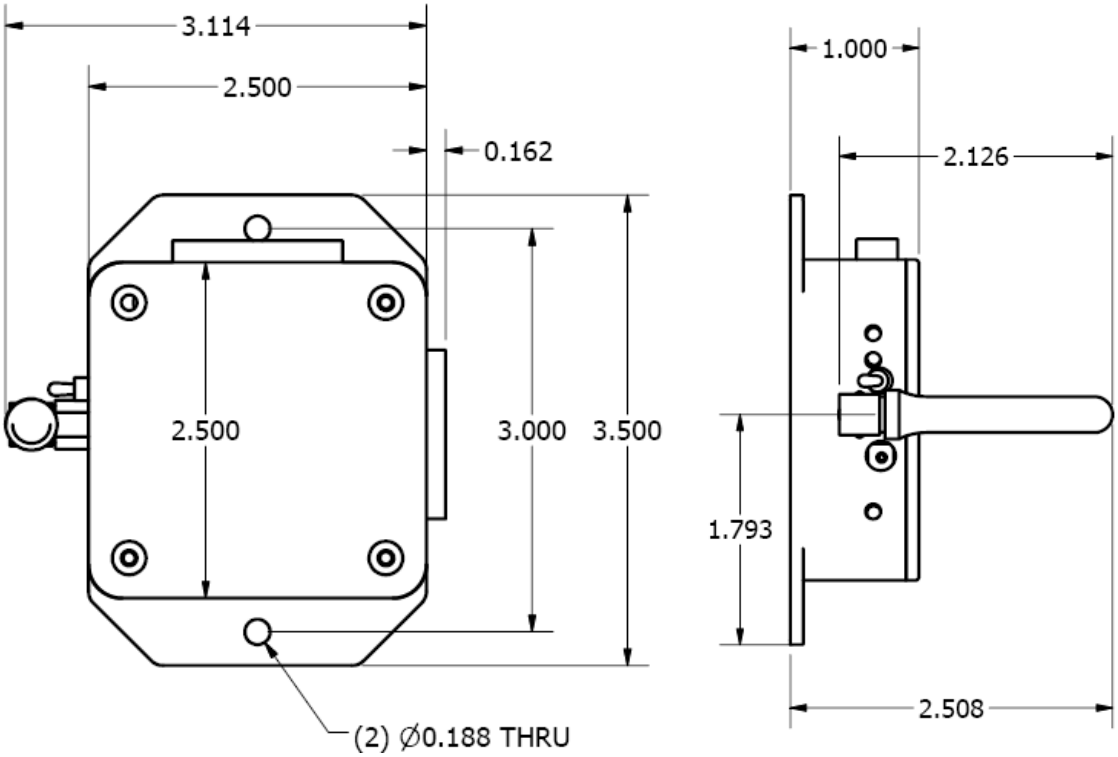


Figure 15

Circuit Board Assembly Dimensions

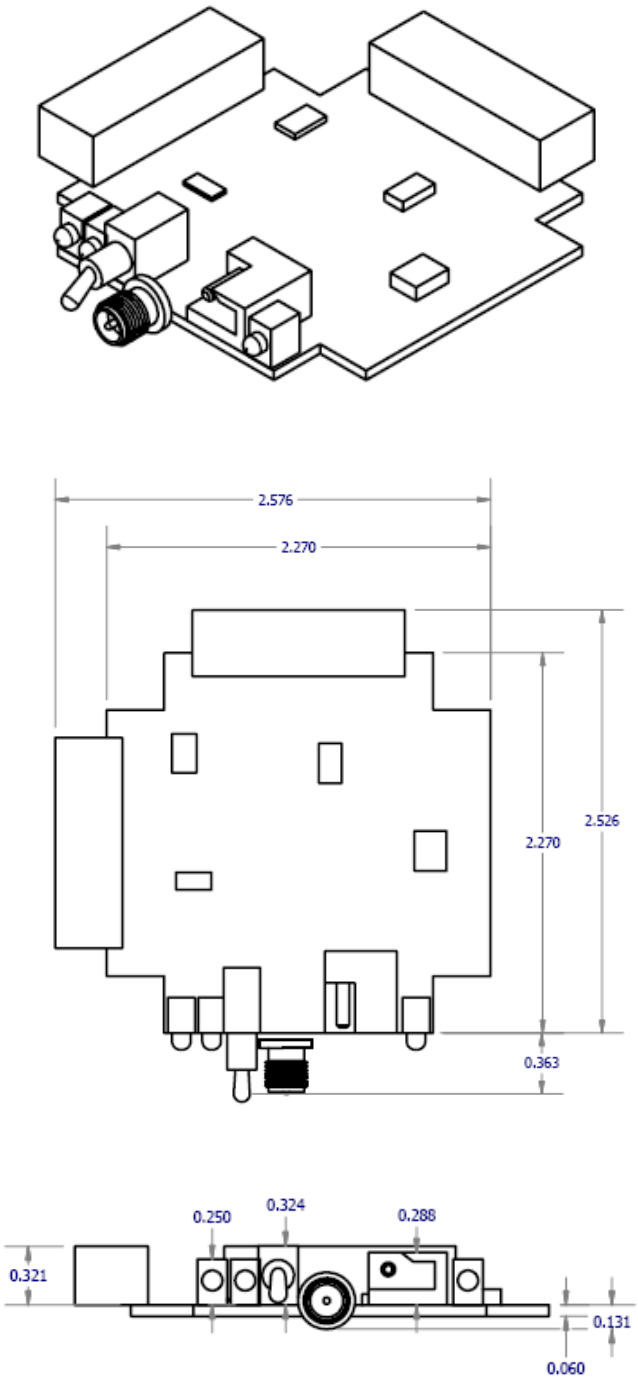


Figure 16

Electrical Block Diagram

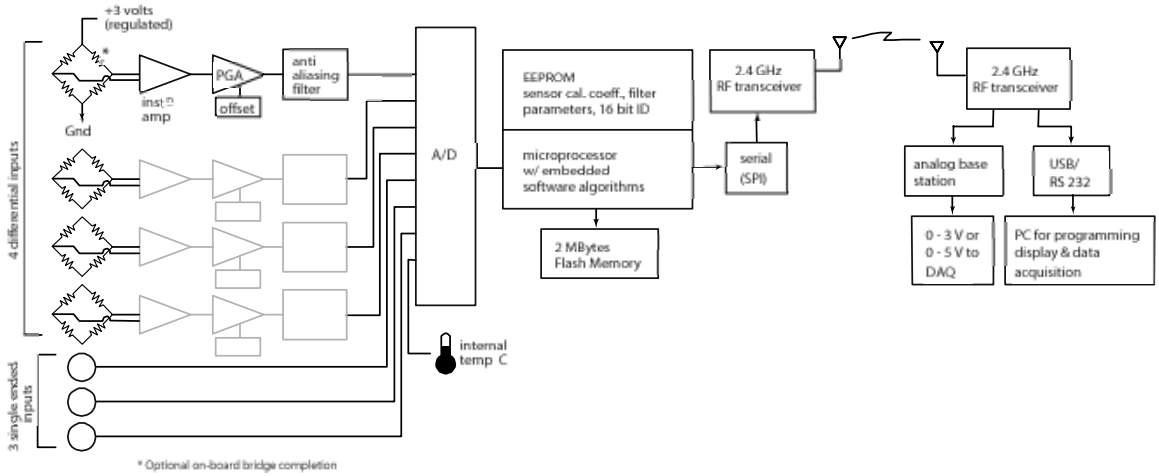


Figure 17

Software

Standard Offering

All V-Link®, SG-Link® and G-Link® starter kits are shipped with a CD containing Agile-Link™ software and High Speed Streaming software. These two softwares support all capabilities of the V-Link®, SG-Link® and G-Link® including datalogging, streaming, low duty cycle, high speed streaming, configuration, data download, data file saving, real-time sensor display and other features.

System Requirements

To use the Agile-Link™ software or High Speed Streaming software, your computer must have the following minimum specifications:

- 1 GHz CPU
- Microsoft® Windows XP Professional SP2 operating system
- CD-ROM drive
- Video resolution 800 X 600
- 32MB video card
- Minimum of 256MB of memory
- Minimum of 50MB of free hard disk space for application
- Microsoft®-compatible mouse

Software Installation

- Place the Agile-Link™ CD in your CD-ROM drive and follow the on-screen instructions to install MicroStrain's Agile-Link™ software.
    - This installation places the Agile-Link™ software on your PC as well as required base station drivers. See *Appendix 2* for more details.
    - Agile-Link™ is designed for use with 2.4 GHz V-Link®, SG-Link® and G-Link®.
- The High Speed Streaming software is designed for use with the 2.4 GHz V-Link®, SG-Link® and G-Link®.
    - If you intend to use High Speed Streaming, install the software from the CD menu.
    - Refer to the *High Speed Streaming Quick Start Guide* for specialized details.
- A *Quick Start Guide* for your particular wireless node (2.4 GHz V-Link®, SG-Link®, or G-Link®) is provided on the CD to get you up and running.

Data Communications Protocol

Customers and/or developers wishing to customize the Agile-Link™ family of wireless nodes and base stations are provided with the Agile-Link™ 2.4 GHz Software Development Kit (SDK). The Agile-Link™ 2.4 GHz Software Development Kit (SDK) is designed for use with the 2.4 GHz V-Link®, SG-Link®, G-Link®, USB Base Station,

Serial Base Station and Analog Base Station. The SDK provides a complete Data Communications Protocol manual as well as code samples for C++, VB and LabVIEW.

The SDK is designed to provide the application builder with all the necessary protocol commands and responses to build robust wireless sensor applications for the Agile-Link™ wireless sensor network.

The Data Communications Protocol manual details these commands:

- Ping base station
- Read base station EEPROM
- Write base station EEPROM
- Short ping
- Read node EEPROM
- Write node EEPROM
- Download page
- Erase session data
- Trigger datalogging session
- Initiate real-time streaming
- Initiate sleep mode
- Read single sensor
- Auto-balance channel
- Long ping
- Initiate low duty cycle
- Initiate high-speed streaming
- Stop node
- …and more

Sample applications demonstrating most protocol commands are provided with fully-commented source code and a compiled executable for Microsoft® C++ 6.0, Microsoft® C++ 7.1, Microsoft® VB 6.0, Microsoft® VB.NET 2003, Microsoft® VB.NET 2005 and LabVIEW® 7.1. The source code contains only objects native to the particular IDE with no third party controls added. The SDK is shipped on the CD with one license for use.

Support

Overview

- MicroStrain is committed to providing timely, knowledgeable, world-class support to its customers.
- We are open 24 X 7 through our web portal.
- We make every attempt to respond to your email the same business day.
- We are always available by telephone during business hours.
- We provide in-depth FAQs, manuals, quick start guides and technical notes.
- Firmware and software upgrades are made available on-line as they become available.
- Code samples in several languages are posted to aid your development.
- We support our customers as we would want to be supported.

Web

Our home page is at URL: www.microstrain.com
Our support page is at URL: http://www.microstrain.com/support_overview.aspx

Email

MicroStrain's Support Engineers make every attempt to respond to emails requesting product support within the same business day. The more detail you can provide, the quicker we will be able to understand your issues and find solutions. Data files, pictures, screen grabs, etc. are all very helpful in generating a well-thought-out solution.

Please email us at: support@microstrain.com

Telephone

MicroStrain's Support Engineers are available by phone Monday through Friday 9:00AM to 5:00PM local time. When calling MicroStrain, indicate to the receptionist that you are calling for product support and you will be promptly routed to a Support Engineer. Please have your equipment ready to test. Every attempt will be made to solve issues while you are on the line.

1.800.449.DVRT(3878) Toll Free in US
1.802.862.6629 telephone
1.802.863.4093 fax

Local time = GMT -05:00 (Eastern Time US & Canada)

SKYPE

MicroStrain's Support Engineers are available by SKYPE Monday through Friday 9:00AM to 5:00PM local. SKYPE name: **microstrain.wireless.support**

RMA

Warranty Return
As described in our 1 Year Warranty contained in the Terms and Conditions stated elsewhere in this manual, MicroStrain will incur for its own account any cost to repair/replace a MicroStrain product covered under the warranty.

Non-warranty Return
All non-warranty repairs/replacements will receive a minimum charge. The minimum charge for standard wireless, displacement and orientation products is US$75.00. The minimum charge for non-standard or custom products is US$150.00. If the repair/replacement charge exceeds the minimum, the minimum is folded into the total repair/replacement cost.

General Instructions
In order to return any MicroStrain product, you must contact us for a Return Merchandise Authorization number (RMA#). Call toll free (800) 449 3878 to obtain an RMA# from a MicroStrain representative.

All returned merchandise must be in the original packaging including manuals, accessories, cables, etc. with the authorization (RMA#) clearly printed on the outside of the package.

MicroStrain is not responsible for shipping costs (from and to the customer) or damage on returned items. Units to be returned should be packed carefully. Please be advised that packages sent by normal US Postal Service cannot be tracked to ensure delivery. Since MicroStrain cannot provide credit for a return without confirming its receipt, we recommend that you use a delivery service that can be tracked and or insured.

Normal turn-around for RMA items is 7 days from receipt of item by MicroStrain.

30 Day Return Policy

All stock product orders from MicroStrain may be returned within 30 days for a full refund. In order to return or exchange all or part of your order, you must contact us for a Return Merchandise Authorization number (RMA#). Call toll free (800) 449 3878 to obtain an RMA# from a MicroStrain representative.

All returned merchandise must be in the original packaging including manuals, accessories, cables, etc. with the authorization (RMA#) clearly printed on the outside of the package. Return requests must be made within 30 days of the receipt date. All free items must be returned together with purchased items in order to receive a full refund. Any shipping and/or handling charges on the original order cannot be refunded. At our discretion, we may levee a restocking fee of 15% of the cost of items returned.

MicroStrain is not responsible for shipping costs or damage on returned items. Units to be returned should be packed carefully. Please be advised that packages sent by normal US Postal Service cannot be tracked to ensure delivery. Since MicroStrain cannot provide credit for a return without confirming its receipt, we recommend that you use a delivery service that can be tracked and or insured.

A 30 Day Return must be initiated by receiving an RMA from MicroStrain.

Terms and Conditions

1. Acceptance of MicroStrain Inc's. Terms and Conditions. By placing an order with MicroStrain, Inc. ("MicroStrain"), Buyer agrees to be bound by these Terms and Conditions of Sale and Software License, if applicable. MicroStrain will not be bound by any of other terms and conditions, regardless of whether Buyer tenders terms and conditions with an order or otherwise and these terms and condition of sale prevail over any conflicting or additional terms of any quote, order, previous agreement, acknowledgment or similar communications between the parties. These Terms and Conditions supersede all prior or contemporaneous oral or written communications, proposals and representations with respect to its subject matter. The term "Products" includes collectively all physical products, Software and Embedded Software (as defined herein).

2. Pricing. All prices are quoted in US dollars, unless otherwise explicitly stated and are valid for ninety (90) days. You shall be responsible for the payment of all shipping charges, costs of freight, taxes, import fees, insurance, duties, value added taxes, and the like. Our minimum order is one hundred ($100.00) dollars, excluding all additional charges, including shipping, taxes and the like.

3. Payment: Payment shall be made in advance, in U.S. dollars, by credit card, bank draft or letter of credit, unless otherwise agreed in writing by MicroStrain. At the sole discretion of MicroStrain, credit terms of net 30 days up to a pre-approved limit may be offered to buyer. A late payment charge of one and a half (1.5%) percent per month, or the maximum percentage rate permitted by law, if lower, shall be charged on all past due balances. Buyer agrees to pay all costs incurred by MicroStrain including, but not limited to, collection fees, court costs and attorney fees, associated with collection of past-due balance.

4. Shipping Terms. All Products delivered to you by us, shall be F.O.B. our distribution center, with risk of loss passing to you upon our delivery of the Products to a common carrier. MicroStrain will arrange payment for shipping and insurance with the carrier, but such costs are the responsibility of Buyer. Delivery times quoted are estimates only and MicroStrain shall not be liable for delays in delivery.

5. Acceptance & Returns. Shipments shall be deemed to have been accepted by the buyer upon receipt of shipment. Any discrepancy in shipment quantity must be reported within five (5) days of receipt of shipment. Buyer may return starter kits or evaluation units for any reason within thirty (30) days of the date of shipping from MicroStrain. All other returns shall be subject to a restocking fee of the greater of twenty-five (25%) percent of the invoiced amount of the returned products or one hundred ($100.00) dollars. To qualify for a credit or refund (excluding shipping, duties or taxes), Buyer must contact MicroStrain in writing for a Return Merchandise Authorization (RMA). All Product returns shall comply with MicroStrain's Return Merchandise Authorization (RMA) policies. Custom Products and modifications of standard Products are not eligible

for return. All returns must be shipped by Buyer to MicroStrain C.I.F. our distribution center as provided in the RMA policies provided by MicroStrain.

6. Compliance with Laws, Rules & Regulations. i.) Products sold may be exported from the United States of America only in accordance with US Export Administration Regulations and diversion contrary to US law is prohibited. Buyer acknowledges that it is eligible to receive Products under US law and agrees to abide by all export or re-export restrictions. ii.) Buyer acknowledges and recognizes that Buyer shall be wholly responsible for compliance with any laws, rules and regulations pertaining to the use of any Product(s) which is incorporated into a Buyer product should such governmental approval be required for research, testing or commercial use.

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Appendix 1: Host-to-Base Station Communication

RS-232

Communication between the Serial base station or the RS-232 interface of the Analog base station *and* the host computer is via a standard RS-232 connection as shown in the RS-232 Signals Definition and RS-232 Asynchronous Character Format tables.

RS-232 Signals Definition

Signal	Name	Direction	Function
TxD	Transmit Data	Host to Base Station	Asynchronous Serial Data from Host
RxD	Receive Data	Base Station to Host	Asynchronous Serial Data to Host
GND	Signal Ground	N/A	Signal Ground Reference

RS-232 Asynchronous Character Format	
Baud Rate	115.2K
Parity	None
Data Bits	8
Stop Bits	1

USB 2.0

Communication between the USB base station or the USB interface of the Analog base station *and* the host computer is via a USB 2.0 compliant connection using a Silicon Laboratories CP2101 USB-to-UART Bridge chip on the base station supported by Silicon Laboratories Virtual Communications Port (VCP) drivers installed on the host PC.

Reference is made to the following Silicon Laboratories documents:
CP2101 Single-Chip USB to UART Bridge Product Brief
CP2101 Data Sheet

Appendix 2: Datalogging with Agile-Link™ software

Datalogging

- Datalogging allows you to sample each sensor (each channel) on a node from 32 samples per channel per second to 2048 samples per channel per second. Sensor data is written to memory on the node as it is sampled; no transmission occurs to the base station. After the datalogging session has completed, data is downloaded and saved to file by Agile-Link™ software. Analysis is conducted thereafter on the resulting data files. Please review the *Sampling Rates* section of this manual for sampling rate details.

Operating one node in datalogging mode

- A datalogging session should be started by setting your configuration.
- Establish communication with the node and right-click to get the drop-down menu.
- Click Configure. The Configuration window will appear.
- Click the Channels tab. Check boxes to enable V-Link®'s channels 1, 2 and 3. Uncheck boxes 4, 5, 6, 7, and 8 to disable these channels. Leave the Offset scroll boxes for channels 1, 2 and 3 at the default value of 512 (mid-scale). Leave the Hardware Gain text boxes for channels 1, 2 and 3 at the default value of 210. Click Apply.
- Click the Datalogging tab. Uncheck box for Continuous Datalogging. Uncheck box for Enable Sensor Event Driven Trigger. Enter the value 1000 into the Sweeps scroll box. Enter the value 256Hz in the Sample Rate drop-down. Note that a datalogging session of approximately 3.9 seconds has been set. Click Apply. Click OK.
- Click View in the menu bar. Click Channel Actions. The Channel Actions windows will appear.
- Click the Resync button. Channels 1, 2 and 3 will now have the Strain action in place indicating that the V-Link® will output engineering units in microstrain.
- Click the small red X in the upper right corner of the Channel Actions window to close the window.
- Right-click on the node icon/label and a pop-up menu will appear.
- Click Datalogging. Click Erase. A confirming message box will appear. Click Yes. A progress bar will appear and disappear. This indicates that the datalogging memory of the node was successfully erased.
- Right-click on the node icon/label and a pop-up menu will appear.
- Click Datalogging. Click Trigger Session. A progress bar will appear and disappear. This indicates that a datalogging session was successfully triggered.
- Right-click on the node icon/label and a pop-up menu will appear.
- Click Datalogging. Click Download. A progress bar will appear and disappear. This indicates that all datalogging sessions were successfully downloaded.

- Note: Any number of datalogging sessions can be run consecutively before downloading. Please review the *Datalogging Memory* section of this manual for capacity details.
- Right-click on the node icon/label and a pop-up menu will appear.
- Click Datalogging. Click Browse Triggers. The Trigger Browser window will appear.
- Click the + sign to the left of the trigger label (example: July 20, 2007 09:36:07) and Trigger 1 will appear. Highlight Trigger 1 and click the Open Trigger. The data in Trigger 1 will be displayed in spreadsheet format (assuming you have Microsoft® Excel installed). This indicates that the data from Trigger 1 was successfully saved to file on your PC.
- Close the spreadsheet. Click OK on Trigger Browser window.

Operating several nodes in datalogging mode (broadcast method)

- Establish communication with several nodes on the same frequency under one base station.
- Configure each node individually for a datalogging session as described in the *Operating one node in datalogging mode* section above. Normally all nodes would be set to the same sample rate, sweep rate, channel actions, etc. for any given session but there is no requirement to do this.
- Right-click the base station and a drop-down menu appears.
- Click Broadcast and the broadcast menu appears.
- Click Erase. A confirming message box will appear. Click Yes. A progress bar will appear and disappear. This indicates that the datalogging memory of the all the nodes was successfully erased.
- Click Broadcast and the broadcast menu appears.
- Click Trigger. The trigger datalogging command will be broadcast to all nodes. The activity LED on the nodes or elapsed time should be observed to determine when the datalogging session has ended. There is no individual response to Agile-Link™ from the nodes when they are completed datalogging.
- Note: Any number of datalogging sessions can be run consecutively before downloading. Please review the *Datalogging Memory* section of this manual for capacity details.
- Proceed to download datalogging from each node individually as described in the *Operating one node in datalogging mode* section above. Broadcast does not allow downloading of several nodes coincidentally.

Appendix 3: Streaming with Agile-Link™ software

Streaming

Streaming allows you to sample each sensor (each channel) on a node at rates as high as 736 samples per channel per second. Sensor data is transmitted to the base station as it is sampled (in real-time) and is collected, displayed and saved by Agile-Link™ software. Please review the *Sampling Rates* section of this manual for sampling rate details.

Operating one node in streaming mode

- A streaming session should be started by setting your configuration. It is assumed that a strain gauge has been applied to channel 1, the Strain wizard has been run, and no strain is being applied to the gauge.
- Establish communication with the node and right-click to get the drop-down menu.
- Click Configure. The Configuration window will appear
- Click the Channels tab. Check the box to enable V-Link®'s channel 1. Uncheck the channel 2 through 8 boxes to disable these channels. Leave the Offset scroll boxes for channel 1 at the default value of 512 (mid-scale). Leave the Hardware Gain text box at the default value of 210. Click Apply.
- Click the Streaming tab. Uncheck box for Continuous Streaming. Enter the value 5000 into the Sweeps scroll box. Note that a streaming session of approximately 6.79 seconds has been set. Click Apply. Click OK.
- Click View in the menu bar. Click Channel Actions. The Channel Actions windows will appear.
- Click the Resync button. Channel 1 will now have the Strain action in place indicating that the V-Link® will output engineering units in microstrain.
- Click the small red X in the upper right corner of the Channel Actions window to close the window.
- Right-click on the node icon/label and a pop-up menu will appear.
- Click Stream. Click Start. The node will start streaming strain in engineering units (microstrain) and display channel 1 as an advancing plot on the Real-time Graph. The Y-axis will auto-scale engineering units and will report channel 1 (green) at or near 0 microstrain. The channel plots will continue along the X-axis until 5000 sweeps (~6.79 seconds) has elapsed. This indicates that the node is successfully streaming its sensor data.
- Move your mouse pointer within the black area of the Real-time Graph. Right-click and a pop-up menu will appear.
- Click Save Stream. A Save As dialog box appears. Accept or modify the File Name for the CSV file that will be saved. Click Save. The dialog box will disappear. This indicates that the streaming data was successfully saved to file on your PC.

Operating up to 4 nodes in streaming mode (broadcast method)

- Establish communication with up to 4 nodes, each paired with a separate base station and each pair on a different frequency.
- Configure each node individually for a streaming session as described in the *Operating one node in streaming mode* section above. Normally all nodes would be set to the same sweep rate, channel actions, etc. for any given session but there is no requirement to do this.
- Hold down the SHIFT key and click each node once to highlight it.
- Release the SHIFT key. Make sure that only nodes are highlighted; not base stations.
- Right-click on any of the highlighted nodes and a drop-down menu appears.
- Click Stream and the nodes will begin streaming data to separate graphs.
- When the streaming ends, move your mouse pointer within the black area of each Real-time Graph. Right-click and a pop-up menu will appear.
- Click Save Stream. A Save As dialog box appears. Accept or modify the File Name for the CSV file that will be saved. Click Save. The dialog box will disappear. This indicates that the streaming data was successfully saved to file on your PC. Do the same for each node/graph.

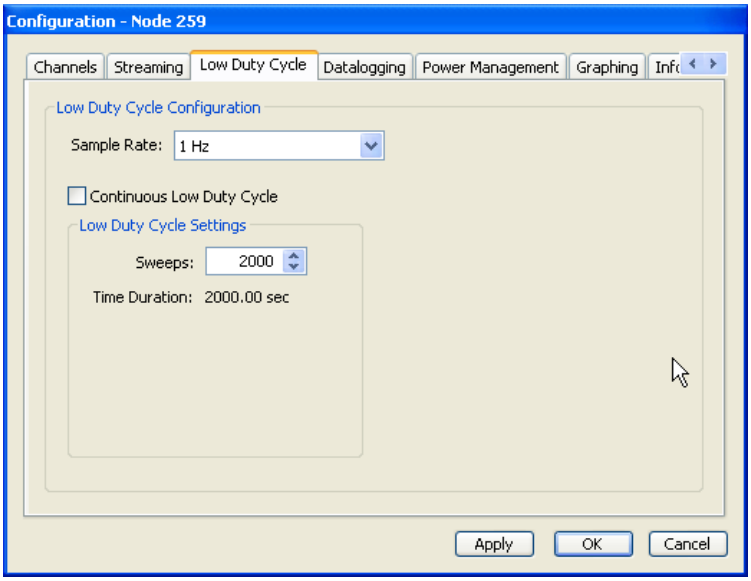
Appendix 4: Low Duty Cycle with Agile-Link™ software

Low Duty Cycle

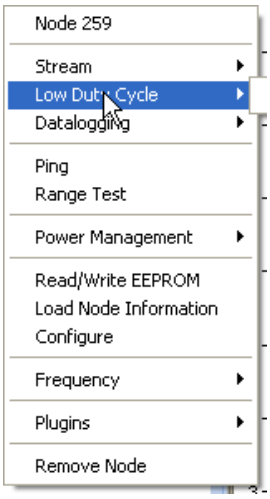
Low Duty Cycle (LDC) allows you to sample each sensor (each channel) on a node from 500 Hz to 1 sample per hour. Sensor data is 'blipped' to the base station and collected, displayed and saved by Agile-Link™ software in real-time. Please review the *Sampling Rates* section of this manual for sampling rate details.

Operating one node in LDC

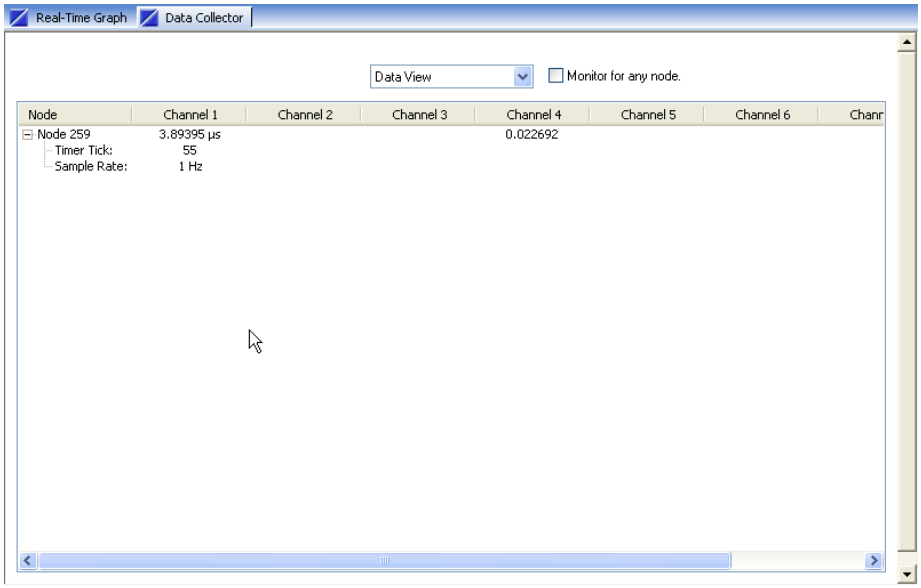
- Low Duty Cycle use should be started by setting your configuration.
- Establish communication with the node and right-click to get the drop-down menu.
- Click Configure and the Configuration window opens.
- Click the Channels tab and apply, as you normally would, the active channels, etc.
- Now click the Low Duty Cycle tab.
- Set the Sample Rate drop-down box to 1Hz, 1 sample per second. *Note:* You may select any of a number of sampling rates ranging from 500 Hz to 1 sample per hour.
- For finite LDC, uncheck the Continuous Low Duty Cycle checkbox.
- Set the Sweeps numscroll to 200, 200 samples over 200 seconds. *Note:* You may select any number of sweeps ranging from 100 to 65500.
- Click Apply.
- Or…
- For continuous LDC, check the Continuous Low Duty Cycle checkbox.
- The Sweeps value is disregarded.
- Click Apply.
- Click OK to close the Configuration window.



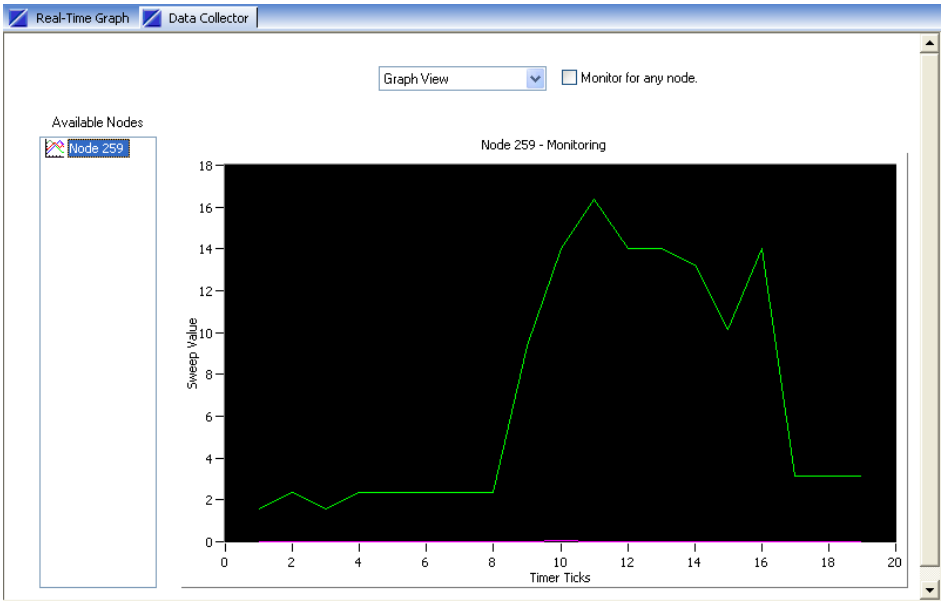
- If you plan to acquire data in engineering units, you should proceed to setting Channel Actions.
- Click View.
- Click Channel Actions.
- The Channel Actions window appears.
- Click Resync to set existing calibrations to the active channels or manually Setup each channel from here. When completed, click the red X in the upper right hand corner of the Channel Actions window to close it.
- To proceed to Low Duty Cycle, right-click the node and the drop-down menu will appear.
- Click Low Duty Cycle.



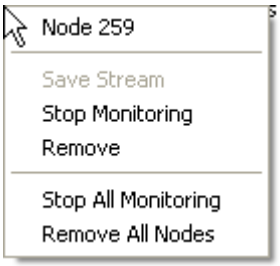
- Click Start and Low Duty Cycle begins sampling and displaying.
- A Data Collector window is spawned in the graphing area.



- As Low Duty Cycle samples are received from the node, their values will be displayed by channel. If engineering units have been applied by Channel Actions, the units will display in those units; otherwise all values will be in raw bits.
- Click the + sign to the left of the node and a tree of information will display indicating current Timer Tick (read Sweep) and the current Sampling Rate.
- Select Graph View from the drop-down above the channel headers and the Low Duty Cycle graphing window will appear.
- Click the node in the Available Node frame and a real-time graph will appear and graph the samples as they arrive.



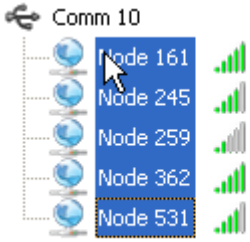
- Select Data View from the drop-down above the channel headers and the Low Duty Cycle data window will reappear.
- In finite Low Duty Cycle, sampling will progress until the number of sweeps set in the Configuration has been reached.
- *Note:* The Agile-Link™ software does not signal the user when a finite LDC session has completed. It will continue to monitor for any samples coming from the node. The user by observation of the Data View, observation of the activity LED on the node, etc. must intervene to continue.
- By right-clicking on the node in the Data Collector window, you receive various menu items.



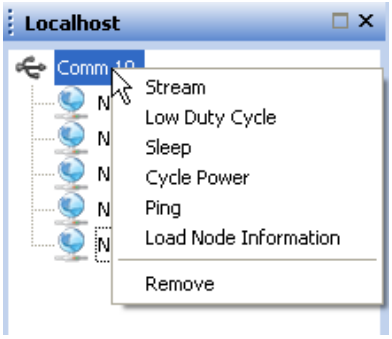
- To stop Low Duty Cycle sampling, click Stop Monitoring.
- To save the Low Duty Cycle session to file, click Save Stream. A 'Save As' window will appear allowing you to name and save the session data. Click OK.
- To close the Data Collector window, click its upper right hand X.
- To return to normal node operations, right-click the node in the Localhost frame to get its main menu.
- *Note:* If you are using continuous Low Duty Cycle sampling or want to prematurely stop a finite Low Duty Cycle sampling, you may do so using the Stop Monitoring and Save Stream software functions. However, the node will continue to operate in Low Duty Cycle mode (and not be able to communicate normally) until you cycle its power. After cycling, you will again be able to communicate normally with the node.

Operating multiple nodes in LDC

- As was stated above, operating multiple nodes in Low Duty Cycle should be started by individually setting each node's configuration and Channel Actions.
- Multiple nodes can be started in Low Duty Cycle at the same instant.
- Press and hold down the Ctrl key.
- Click each node that you want to include in the session.

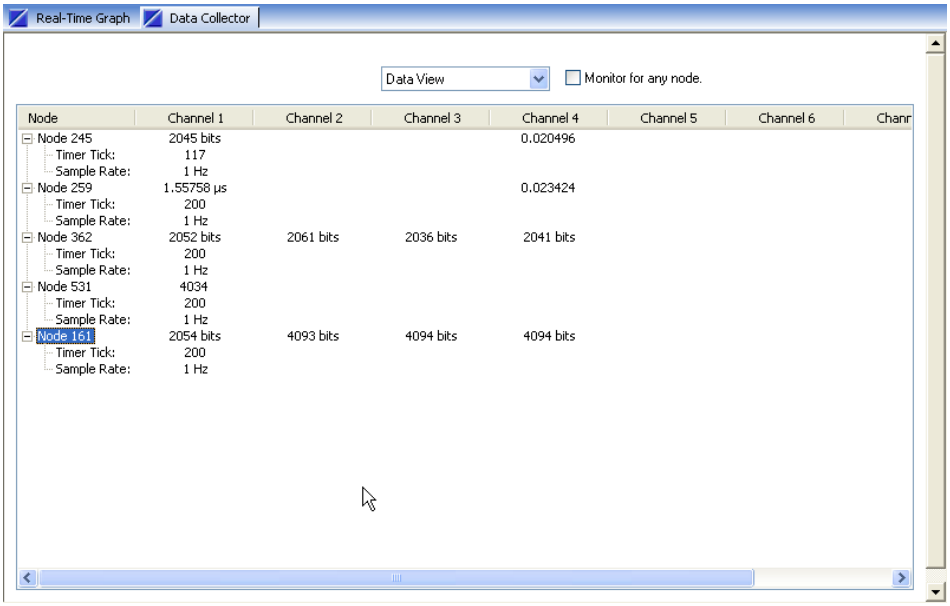


- Release the Ctrl key.
- Right-click the base station and a menu will appear.

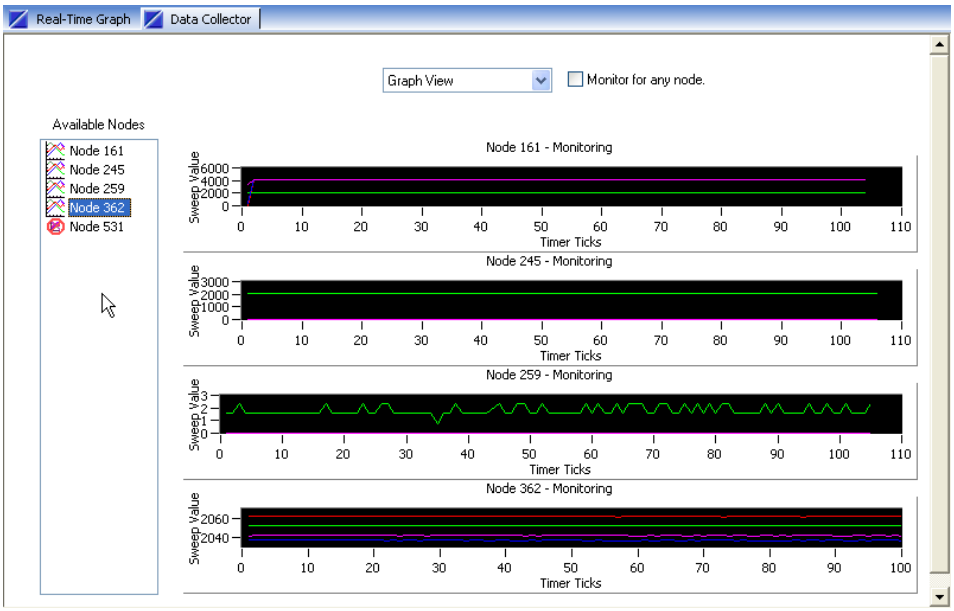


- Click Low Duty Cycle. All nodes that were selected will now begin LDC and will all be sampled by the software.
- *Note:* The nodes will commence at the same instant and although each node runs independently, the nodes will have near real-time synchronization subject to very small error as a result of their individual clock crystals.

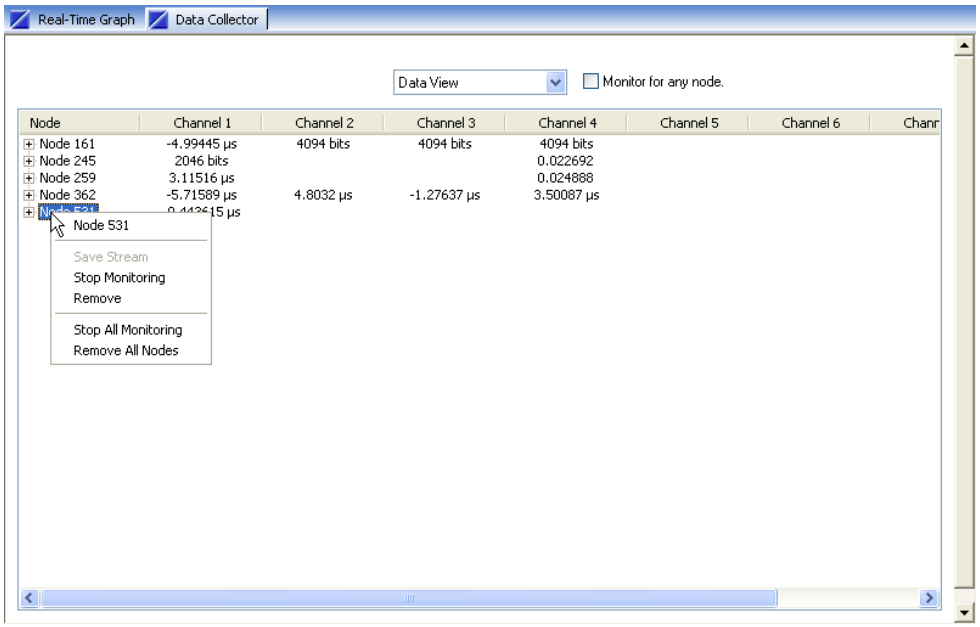
- *Note:* Alternatively, all nodes assigned to a base station can be started at the same time. Right-click the base station and click LDC Monitor Node. A Data Collector window will spawn and all nodes will automatically start Low Duty Cycle.
- As before, a Data Collector window is spawned in the graphing area and all nodes being captured are displayed.



- Click Graph View and the graphing window appears.
- Click the nodes you want to graph in the Available Nodes frame. A limit of 4 graphs on-screen is enforced.



- Return to the Data View, right-click any of the nodes and the menu appears. You can deal with individual nodes as before to Stop Monitoring and/or to Save Stream. You may also click Stop All Monitoring to stop sampling all the nodes at once. ***To return to normal operations, all nodes must be stopped.***
- *Note:* The Monitor For Any Node checkbox can be utilized to collect all nodes transmitting LDC or to limit collection to only those nodes selected. Likewise, the Remove Node or Remove All Nodes menu items can be used to throttle collection.
- To close the Data Collector window, click its upper right hand X.



Additional Notes

- In the case of multiple nodes, Low Duty Cycle is not expected to and will not deliver every data sample that is transmitted. Contention occurs and the more nodes you add and the higher sampling rates that you apply add to the overall loss of packets.
- A time stamp based on host time writes out with each row of data in files saved from sessions 1 Hz or slower.

Appendix 5: High Speed Streaming with High Speed Streaming software

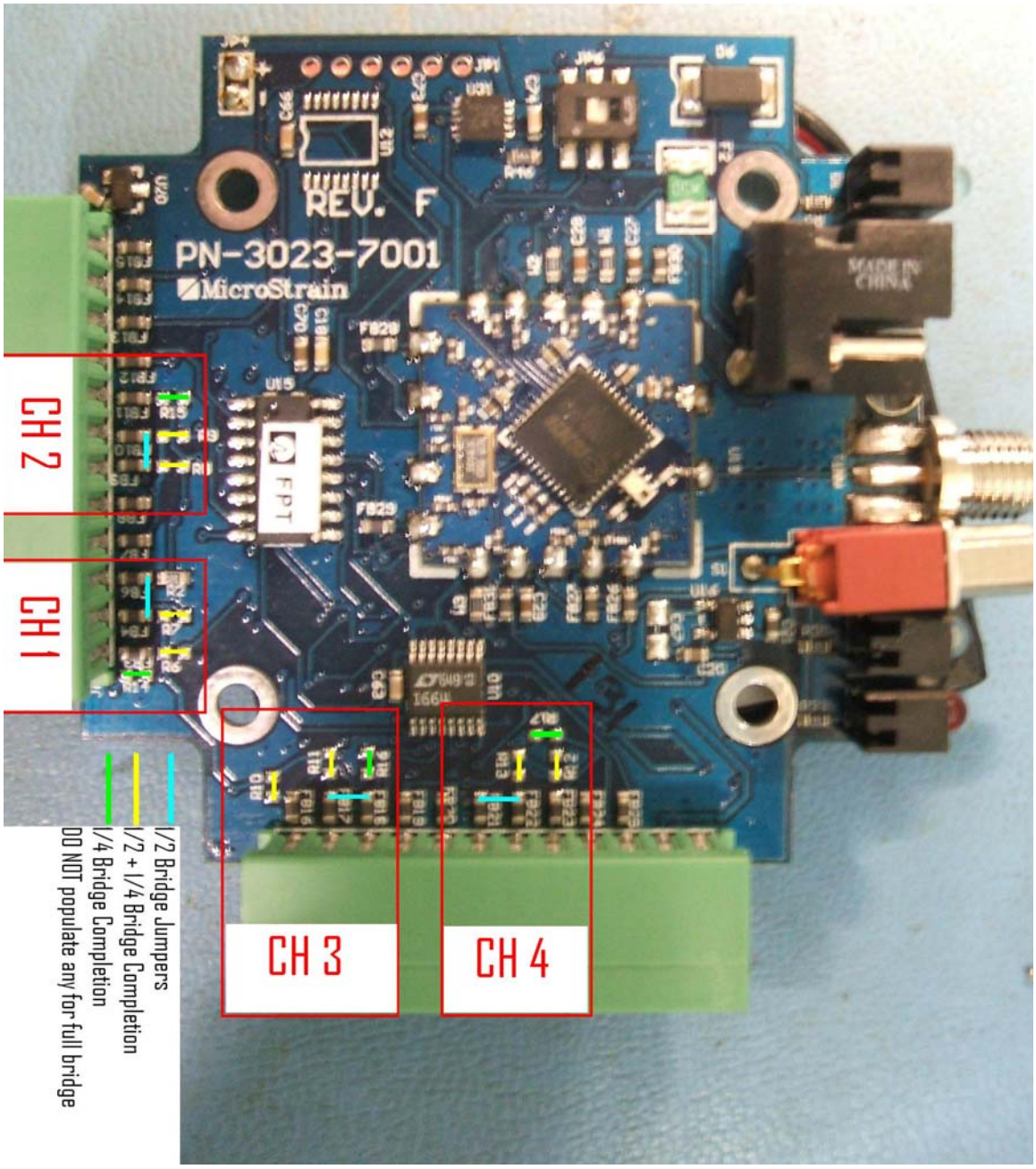
High Speed Streaming
High Speed Streaming allows you to sample each sensor (each channel) on a node at rates as high as 4000 samples per channel per second. Sensor data is transmitted to the base station as it is sampled (in real-time) and is collected, displayed and saved by the High Speed Streaming software. Please review the *Sampling Rates* section of this manual for sampling rate details.

Operating one node in high speed streaming mode
Please refer to the High Speed Streaming Quick Start Guide which is contained on the Agile-Link™ CD and on our web site.

Appendix 6: Bridge Completion Resistors

The picture below shows how to determine what bridge completion is in place on your V-Link®. Jumpers provide a direct connection between circuit points; resistors will have the value of the specified bridge completion.

DO NOT ATTEMPT TO MODIFY YOUR V-LINK® BRIDGE RESISTORS WITHOUT PRIOR CONSULATION WITH MICROSTRAIN SUPPORT ENGINEERS. ANY ATTEMPT WILL IMMEDIATELY INVALIDATE THE PRODUCT WARRANTY.



Appendix 7: Attaching a Thermocouple

A step-by-step instruction for thermocouple use with the V-Link® is available at:
http://www.microstrain.com/tech_notes/TechNote_2400_V-Link_Thermocouples.pdf